On the Insects, COLEOPTEROUS, HYMENOPTEROUS and DIPTEROUS, inhabiting the Galls of certain species of Willow.

Part 1st.—DIPTERA.

BY BENJ. D. WALSH, M A.

I propose in the following pages to name and describe the Galls, which I have found on several species of Willow in the neighborhood of Rock Island, Illinois, and also the insects which produce those galls, not only in the imago state, but in all their states so far as known to me. I propose at the same time to name, and, so far as they are hitherto undescribed, to describe several other insects, which habitually breed in the galls formed by the true gall-makers, and which, as they feed on the substance of the gall itself and only occasionally or incidentally destroy the gall-making insect, may be appropriately considered as Inquilines or Guest-flies. Besides these last, there is a great variety of true Parasites, mostly Chalcididæ, which prey, not on the gall, but solely and exclusively on the body of the Gall-maker or on that of some of the Inquilines, and which I shall only refer to so far as they are concerned with the other subjects herein discussed. The field thus opened to our view, though very extensive, is almost an untrodden one; for out of the great multitude of N. A. willow-galls, but two, so far as I am aware, have been up to this day named and described, viz. *Salicis* Fitch (=*rigidæ* O. S.) and *strobiloides* O. S.; and in the case of the latter, the insect that produces it has hitherto been totally unknown in all its states.

As in my other published descriptions, I have wherever possible described from a large number of specimens and carefully given all the variations, so as to define the species itself and not merely the individual, stating in every case the number of specimens as a measure of the value of the description. I have also, as heretofore, aimed at making the descriptions as accurate and definite as possible, and with this object in view have uniformly sacrificed brevity to precision. To the more advanced student, perhaps, this is not always desirable; but to the neophyte what information does it convey to say, for example, "Antennal joints spherical, pedicels short, verticils long," when he knows not how long the pedicels and verticils usually are? Whereas if we say, "Antennal joints spherical, pedicels ½ as long as the spherical part of each joint, verticils as long as the two entire joints from which

they spring," he can form in his mind's eye a complete idea of the antenna, and an artist might even draw a very tolerably accurate picture of it from the description alone. In a Synopsis, indeed, of species already described, such diffuseness is not necessary, for we know where to go for the full description; but he that undertakes to describe new species should endeavor to describe them in so full, definite and precise a manner, as to comprehend every variety that can possibly come under the notice of the student, and to separate his new species effectually from all species already described or hereafter to be described.

I regret much that, from the almost total lack of scientific facilities in the Great West, I have been unable to compare the Willow-galls now described with the published Willow-galls of Europe, so as to decide the interesting question whether any of them are identical. To the Eastern Entomologist, who lives, not in the backwoods but in a civilized community, this would be comparatively an easy task and indeed almost a matter of course. To the Western Entomologist it is an impossibility. Illinois, as the last Census shows, produces now more maize and more wheat than any other State in the Union; and, as the New York Market Reports show, she also produces more beef cattle than any other State in the Union. But she has hitherto failed to produce a single Public Scientific Library worthy of her wealth and her great and growing resources.

It is well known to Botanists that the genus Salix (willow) is a very extensive and difficult one, and that authors have differed greatly as to whether certain forms are true species or mere varieties. I am indebted to M. S. Bebb, Esq., of Washington, D. C., who has paid special attention to this Botanical group, for naming the species found in this vicinity from specimens which I had prepared for that express purpose. The accurate determination of the species of our Willows is the more valuable and important here, because I find it to be a very general, though probably not a universal rule, that each gall-making insect confines itself to a particular species of Willow. As to the larger and more abundant and more conspicuous galls, such as *Salicis brassicoides* n. sp., *S. rhodoides* n. sp., *S. strobiloides* O. S., *S. ænigma* n. sp. and *S. pomum* n. sp., I am quite certain from long, close and continued observation, that the rule holds good universally so far as regards the several species of Willow found near Rock Island. I have repeatedly, for

instance, noticed a willow-bush bearing apparently numerous specimens of both *S. brassicoides* and *S. strobiloides*, but on examining the foliage I have always found, that the two different willows that bear these two galls were here growing promiscuously from the same spot of ground, and that each branch of each species bore its appropriate gall, and never the gall peculiar to the other species of willow. The instances where these two willows grew side by side, or only removed a short distance from each other, and where I found each bearing exclusively its appropriate gall, are almost innumerable. This fact is the more remarkable, because the Willows form a very extensive genus, with the species often separated from each other by very minute distinctions. We meet, however, with an analogous case in the gall-making Hymenopterous genus *Cynips*, where with occasional exceptions each species is confined to a distinct species of Oak; while, on the other hand, the gall-making *Cecidomyia* of the Hickory are said by Osten Sacken to be "found indifferently on the various species of that tree." (*Synopsis Dipt. N. A.*, p. 191.)

It does not follow, however, because certain galls are found exclusively on particular species of willow near Rock Island, that the identical same gall may not occur in other localities on other species of willow which do not grow near Rock Island. A willow-gall (*Salicis* Fitch, which being preoccupied has been changed by Osten Sacken to *rigidæ*) closely resembling, so far as can be judged from Dr. Harris's brief description, my *S. siliqua*, which is found on Salix humilis Marshall, is said by Dr. Fitch to be found on S. rigida and S. lucida; and I have found a gall which differs only in some few slight characters from that found on S. humilis, and which for the present I consider as identical with it, to occur sparingly on S. cordata Muhl.; and though I could not succeed in breeding the imago from this gall, yet the larvæ of the two galls were absolutely undistinguishable. S. rigida, one of the two willows on which Dr. Fitch found his gall, is regarded now by most botanists, according to Mr. Bebb, as a mere variety of S. cordata on which I found one of my two galls. I have also found a single specimen of what for the present I regard as the same gall on S. discolor. So that if the four galls be in reality identical, we have here a case of the same gall growing on four distinct species of willow, S. rigida (=S. cordata), S. lucida, S. humilis and S. discolor.

The species of willow which grow near Rock Island, all of them in

great abundance, with the single exception of the first, which is exceedingly rare, are named by Mr. Bebb as follows :—1*st*. Salix discolor Muhl. 2*nd*. S. cordata Muhl. 3*rd*. S. longifolia Muhl. 4*th*. S. nigra Marshall. 5*th*. S. humilis Marshall. The *first* species produces one very distinct gall, No. 6, and two that are apparently identical with Nos. 8 & 12, which occur on S. humilis. The *second* produces four very distinct galls, Nos. 2, 10, 17 & 20, besides varieties of the very same two galls, Nos. 8 & 12, of which varieties occur on S. discolor. The *third* three galls, Nos. 1, 9 & 19. The *fourth* two galls, Nos. 14 & 15. And the *fifth* and last the astonishing number of ten distinct galls, Nos. 4, 5, 7, 8, 11, 12, 13, 16, 18 & 21. Mr. Bebb observes that "the tendency of this species to produce a remarkable number of galls was observed by Muhlenberg, and he therefore called it S. conifera." Besides the above, I have also described a gall (No. 3) growing on S. rostrata, a northern species which does not occur so far south as Rock Island, and a coleopterous gall or rather pseudo-gall, (No. 22,) which grows on S. longifolia, and also, so far as can be judged from the gall alone, on a species of the allied genus Populus, P. angulata the common cottonwood. In addition to the five species of willow catalogued above, I noticed in the woods a single large tree of what I believe is a sixth distinct species, but too late in the season to obtain specimens of the inflorescence. From the foliage and a portion of the fruit forwarded to Mr. Bebb, he decides that it must be either S. nigra, which I am pretty sure it is not, or some foreign species. Since however this tree bore no galls whatever, the question, in an entomological point of view, is of no manner of interest, except so far as it may illustrate what I rather believe to be a general law, that exotic willows bear no galls. So far as my very limited observation goes, exotic Willows (S. babylonica and S. alba) bear no galls at all; which is collateral proof of the theory, that generally each distinct gall is peculiar to a distinct species of Willow, for if it had been otherwise, the indigenous gall-makers would have immediately attacked them when they were imported.

Of the above twenty-one galls, excluding the Coleopterous pseudo-gall and the doubtful galls on S. discolor and S. cordata, twelve (Nos. 1–15) are made by Dipterous insects belonging to the family *Cecidomyidæ*, and six (Nos. 16—21) by Hymenopterous insects belonging to the family *Tenthredinidæ*. In addition to a great number of insects which

occasionally inhabit these galls, there are of true Inquilines which seem to inhabit them exclusively, but without always confining themselves to one particular species of gall, seven cecidomyidous species, two tenthredinidous species, and at least one and probably four or five Coleoptera, besides seven species of Microlepidoptera, which Dr. Clemens has kindly undertaken to name and describe from specimens with which I have furnished him. Each of the above, with the exception of the last, will be noticed below under the head of the Order to which it belongs.

From the great number of these Inquilines, it must be obvious that there is considerable danger of mistaking them for the true authors of the gall. For example, any one who examines the Tenthredinidous gall *S. pomum* n sp. in the middle of the summer, will find nearly half of them to contain *Anthonomus scutellatus* Schönh. either in the larva, pupa or imago state, unaccompanied by any Tenthredinidous larva; whence, as I myself formerly did, he would be very likely to jump to the conclusion that it was that insect that made the gall. A more extensive knowledge, however, of the galls of the willow will soon show him, that this same beetle occurs in great numbers in several other galls, some of them of a totally different structure; and hence he will properly infer that the same insect cannot make two totally different kinds of gall, and consequently that it must be a mere inquiline in *S. pomum*. There is another criterion which will be found very useful in determining the question, which of two insects bred from a given gall is the true Gall-maker and which the Inquiline. In all monothalamous galls, whether Cecidomyidous or Cynipidous, there is always a central cell or nucleus, in which the gall-maker resides, the inquilines either residing outside the central cell, or, as I believe to be often the case, and as must be the case with the Snout-beetle just now referred to, destroying the tenant of the central cell and occupying his place. If then non-parasitic pupæ taken from the central cell of a gall are isolated in one vial, and non-parasitic pupæ taken from outside the central cell are isolated in another vial, and the former always produce the imago A, and the latter always produce the imago B, it must be evident that A is in all probability the gall-maker and B beyond all doubt an inquiline. In this manner I ascertained that the pine-cone like gall *S. strobiloides* O. S. is not made by the cecidomyidous larva, which was observed by Osten Sacken to live in great numbers under the

scales of the pine-cone, but by a distinct and much larger *Cecidomyia*, hitherto unobserved, which inhabits the very heart or centre of the pine-cone, the smaller *Cecidomyia* being mere inquilines. (See Osten Sacken apud Loew, *Synops. Dipt. N. A.* p. 203.) We may also in some cases get useful hints on this subject from the structure of the gall itself. For instance, in many Tenthredinidous galls, e. g. *S. ovulum* n. sp., on laying them bare to their foundation, the slit cut by the saw of the mother insect may be plainly seen. Hence, even if, as I have actually done, we should breed a *Cecidomyia* from such a gall, we may know that it must be a mere inquiline, because the Cecidomyidous oviduct is not capable of cutting such a slit. Still, with every possible precaution, mistakes will sometimes be made, as to the character of the insect that really makes the gall. For example, because, from the gall *quercus pilulæ* Walsh, I had bred ♂ ♀ of an Inquilinous Cynipide, I jumped to the conclusion that the gall itself must be the work of some unknown Psenidous Cynipide. (*Proc. Ent. Soc. Phil.* II. pp. 481—2.) Whereas I have since become aware that it is the work of a Cecidomyia known at present only in the larva state, and that it had been briefly described, but not named, by Osten Sacken. (*Syn. Dipt. N. A.* p. 201.) No other instance is on record, as Baron Osten Sacken has obligingly informed me, of a true Cynipide being inquilinous in a Cecidomyidous gall.

Some groups of insects that are commonly inquilinous in galls have no true gall-making insects belonging to the same family as they do, of which case I believe that we find an example in the Coleopterous *Curculionidæ*. (See below under No. 15.) But the great majority of them, e. g. the inquilinous Gall-flies, the inquilinous Saw-flies, and the inquilinous Gall-gnats, have many true gall-making species belonging, not only to the same family, but in the case of the Gall-gnats and Saw-flies even to the same genera, viz. *Cecidomyia* and *Nematus*, that they themselves belong to. Hence an observation of Osten Sacken's with regard more especially to the Gall-flies, which I formerly quoted and relied on, that "it seems hardly probable that species of the same genus should sometimes be true Gall-producers and sometimes Parasites [i. e. inquilines]" must be taken *cum grano salis* so far as it may apply to the Gall-gnats and Saw-flies, though it seems perfectly correct as limited to the Gall-flies. (*Proc. Ent. Soc. Phil.* I. p. 49.) What is very remarkable

about these inquilinous insects, which have true gall-makers closely allied to them, is that they do not invariably confine themselves to the galls of their allies, but occasionally inhabit galls made by insects that even belong to different Orders. For example, the Cecidomyidous gall *Q. pilulæ* Walsh, as was just now stated, is inhabited by a Cynipide, Ceroptres* (amblynotus) inermis Walsh, and conversely from the Cynipidous gall *Q. petiliocola* O. S., I bred July 11th two specimens of a *Lasioptera* (*Cecidomyidæ*) resembling somewhat *L. solidaginis* O. S. but perfectly distinct from that species. Again, numerous instances are given in this Paper, where Saw-flies are inquilinous in the galls of Gall-gnats, and Gall-gnats are inquilinous in the galls of Saw-flies, as may be readily seen from the lists of Inquilines under DIPTERA and HYMENOPTERA. But in all such cases this appears to be the exception and not the rule. It should be remembered, that the same gall is often inhabited by several different species of inquilines, sometimes belonging to widely distinct groups, as, for example, the Cynipidous gall *Q. petiolicola* O. S. is inhabited not only by the Guest Gall-gnat mentioned above, but by a Guest Gall-fly, *Ceroptres* (*amblynotus*) *petiolicola* O. S.; (*Proc. Ent. Soc. Phil.* I. p. 67 and II. p. 487,) and that many species of these Guests habitually live in the galls of several different species of Hosts, many instances of which will be found below. It is even occasionally the case, that one and the same species is sometimes inquilinous in the galls of other insects, and sometimes attacks natural substances which are in nowise connected with galls, of which one instance is apparently found in the Dipterous *Drosophila amœna* Lw., and another notable one occurs in the common Curculio (*Conotrachelus nenuphar* Hbst.), one brood of which attacks the fleshy part of the Plum, Peach, &c., and another brood habitually lives in what will be shown below, to be in all probability a true Cecidomyidous gall—the well-known "Black-knot" on the Plum-tree. (See under No. 15.)

Nothing gives us a better idea of the prodigious exuberance of Insect Life, and of the manner in which one insect is often dependent upon another for its very existence, than to count up the species which haunt,

*Baron Osten Sacken tells me that he has learned from Dr. Rheinhardt of Germany, that the insects provisionally referred by him to Hartig's imperfectly defined genus *Amblynotus* belong in reality to Hartig's genus *Ceroptres*, or at all events must form a new genus closely allied to *Ceroptres*.

either habitually or occasionally, one of these Willow-galls, and live either upon the substance of the gall itself or upon the bodies of other insects that live upon the substance of the gall. In the single gall *S. brassicoides* n. sp. there dwell the Cecidomyia which is the maker of the gall—four inquilinous Cecidomyia—an inquilinous saw-fly (Hymenoptera)—five distinct species of Microlepidoptera, some feeding on the external leaves of the gall, and some burrowing into the heart of the cabbage, but scarcely ever penetrating into the central cell, so as to destroy the larva that provides them with food and lodging—two or three Coleoptera—a Psocus (Pseudoneuroptera)—a Heteropterous insect found abundantly in several other willow-galls—an Aphis which is also found on the leaves of the willow, but peculiarly affects this gall—and preying on the Aphides the larva of a Chrysopa (Neuroptera) and the larva of a Syrphide (Diptera)—besides four or five species of Chalcididæ, one Braconide Ichneumon (Hymenoptera) and one Tachinide (Diptera), which prey on the Cecidomyia and the Microlepidoptera—making altogether about two dozen distinct species and representing every one of the eight Orders, if with Sieboldt, Erichson and Hagen we refer Pseudoneuroptera to Orthoptera. If this one little gall and the insect that produces it were swept out of existence, how the whole world of insects would be convulsed as by an earthquake! How many species would be compelled to resort for food to other sources, thereby grievously disarranging the due balance of Insect Life! How many others would probably perish from off the face of the earth, or be greatly reduced in numbers! Yet to the eye of the common observer this gall is nothing but an unmeaning mass of leaves, of the origin and history of which he knows nothing and cares nothing!

The Dervise in the Eastern Fable claimed to have discovered the language of birds, while to the vulgar their notes were mere inarticulate sounds without passion and without meaning. The Entomologist does not indeed pretend to understand the language of Insects, for, as they all breathe through spiracles or branchiæ, their mouths are everlastingly dumb. But from signs and tokens well known to him he can interpret their actions, and recognize at a glance what object they are pursuing, whether sport, or love, or war, or food for themselves, or food for their future progeny, or the construction of habitations either for

themselves or for that future progeny which they are doomed never to behold. Under every stone, under every clod, and even under the most despised substances, there is a little world in miniature opened to his eyes. And there scarcely grows a plant but what contains, in Nature's own hieroglyphs, a whole volume of Natural History written by the finger of the Great Author of our being.

DIPTERA.—Family Cecidomyidæ.

Many years ago, before the science of Entomology had any existence, the old herbalist Gerard, noticing a rose-like gall very abundant on a British species of willow, concluded that it was a purely vegetable production, and that the willow which bore it formed a distinct species, which he accordingly named "the Rose-willow"; and even Swammerdam, who ought to have known better, fell into the same error. (Kby & Sp. *Intr.* Letter 14, p. 254. Westw. *Intr.* II. p. 519.) Up to a very recent date, from some unaccountable cause, entomologists who recognized this gall as the work of insects, attributed it, not to a gall-gnat nor even to a saw-fly, but to a *Cynips*. (Kby & Sp. *ibid.*) Westwood, however, clearly recognizes the gall of the "Rose-willow" as the work of a *Cecidomyia*, (*Introd.* II. p. 519,) and I am indebted to Baron Osten Sacken for the following quotations from Dr. Hartig in reference to this matter. "There are no *Cynipidæ* on the willow, and the galls ascribed to *Cynips viminalis*, *C. capreæ*, *C. americæ* and *C. salicis strobili* belong either to *Cecidomyiæ* or *Aphides*." (Germ. *Zeitsch.* II. p. 176.)—"I doubt very much whether other than parasitical Gall-flies [Figitidæ?] occur on the willow." (*Ibid.* IV. p. 421.) To which it is added that "three species of *Xystus* (= the Figitide genus *Allotria*) are described by Hartig as being bred from the willow-gall of the Tenthredo *Nematus Vallisnierii*."

As already stated, all the true Willow-galls I have so far met with are the work either of gall-gnats or of saw-flies, and none that I have seen are produced by *Aphidæ*, as seems to be asserted above of certain European willow-galls by Hartig. I once, indeed, found a colony of a species of Aphis, that inhabits S. cordata, surrounded by what at first sight looked like a large, subspherical gall; but on breaking it open I saw at once that it was the work of the attendant ants, and composed of particles of dry vegetable matter agglutinated together, in the man-

ner described by Mr. Wm. Couper, (*Proc. Ent. Soc. Phil.* I. p. 373.) May it not be possible that the Willow-galls attributed to *Aphides* by Hartig are of a similar nature? Whenever a particular genus of plants, common to both N. A. and Europe, is infested by a particular genus of gall-making insects, it is generally the case that the same genus of Insects occurs upon the same genus of plants both in the Old and New World. Now if there really exist in the U. S. *Aphidæ* that produce galls on our willows, I can scarcely believe that they should have all managed to escape my notice. Still, like all other negative arguments, such reasoning as this is not entitled to much weight.

The genus *Cecidomyia* differs from most other genera of gall-producing insects, in that it occurs on very numerous and widely distinct genera of plants. In Osten Sacken's excellent Memoir on this Family, without the assistance of which I should not have ventured upon this Paper, N. A. *Cecidomyidæ*, many of them known only in the larva state, are enumerated as occurring on Hickories (Carya) of different kinds, on the red Maple (Acer), on the Ash (Fraxinus), on Oaks of different kinds (Quercus), on the Hornbeam (Carpinus), on the Tulip tree (Liriodendron), on the Willow (Salix), the Grape-vine (Vitis), the Locust (Robinia), the Alder (Alnus), the Gooseberry (Ribes), the Blackberry (Rubus), and the Pine (Pinus), besides Vaccinium, (or Gaylussacia?), Solidago, Impatiens, Agrostis, Chrysopsis, and the cereals wheat, rye, &c., (*Dipt. N. A.* 188—190.) Even the twelve N. A. species referred to the genus *Cecidomyia*, where the perfect insect is known as well as its larva, occur on eight distinct genera of plants. (*Ibid.*) What a contrast with *Cynips*, of which there are now about a score described N. A. species, all found on different species of Oak! We may observe, however, that as in the Cynips of the Oak, so also in the Cecidomyia of the Willow, it is a very general rule that the gall, when it grows on a twig, kills that twig unless it is pretty large, so that the presence of either of these two genera operates here as Nature's own pruning-knife.

But the most remarkable feature about the *Cecidomyidæ* is the generally dull, monotonous character of their coloration and ornamentation, the extreme similarity of many species, and the apparent identity of others, which we yet know, from the wide difference of the galls produced by them, must be distinct species. Hence Loew has remarked

that "Gall-gnats cannot be recognizably described from single dried specimens, unless they are distinguished by some striking peculiarities;" (*Dipt. N. A.* p. 187;) and Osten Sacken observes as follows:—

> It is a peculiarity of the family of *Cecidomyidæ*, that its natural history has always been studied in close connection with its classification. This is owing chiefly to the fact that *the gall*, the produce of the insect in its first stage of life, is generally a more striking object in nature than the *insect itself*. The latter, small, tiny, difficult to preserve on account of their extreme delicacy, still more difficult to distinguish from their congeners on account of the uniformity of their appearance and coloring, would afford a very unsatisfactory object of study, unless in connection with the varied deformations which their larvæ produce on plants. (*Dipt. N. A.* p. 173.)

I find it utterly impossible in one case to distinguish from each other the dried ♀ imagos of two undoubtedly distinct species, which form distinct galls of a perfectly distinct structure on different parts of the same Willow, and the pupal integuments of which are structurally very distinct, viz. *Cec. s. rhodoides* n. sp. and *Cec. s. siliqua* n. sp.? I had hoped that, by taking descriptions of numerous specimens of recent *Cecidomyia*, and especially of the abdomen which often loses its coloration almost entirely when dried, some sharply-defined distinctive characters might be arrived at. But I have found from these descriptions that the same species, and even the same living individual of the same species, varies greatly in the coloration of the abdomen according to the degree of its maturity, and that what was at an early period in its existence yellowish or reddish, gradually becomes, in the course of a day or two, and sometimes even in the course of a few hours, brown or blackish. I have even repeatedly placed the recently killed ♀ ♀ produced from the above two galls side by side, and have found myself utterly unable to discover any constant distinctive character whatever, though it is barely possible that the structure of the ♂ antennæ may differ. In solitary individuals indeed it is easy enough sometimes to point out distinctive characters; but on comparing many individuals belonging to the same species, such characters are very generally found to be inconstant and worthless. Lest it should be assumed that the characters in my specimens might have been changed by chemicals, such as chloroform, &c., used to deprive them of life, it is proper to state here, that I kill all flies by simply immersing the vial or bottle, in which they are confined, into hot water up to the cork.

Under these circumstances the mind naturally reverts to the idea, that the difference in the gall is caused by the difference in its location, whether in the bud, or in the wood, or on the surface of the leaf, of the same species of willow, and that the two supposed distinct species of *Cecidomyia* are in reality identical. But on the very same species of Willow, S. humilis, there occur two galls, *S. rhodoides* n. sp. and *S. gnaphalioides* n. sp., differing indeed in size, but constructed upon precisely the same principle, both of them always solitary, both of them monothalamous, and both of them formed by a similar deformation of the terminal bud of a twig. Although each of these two galls may be recognized at the first glance, and no two galls can be more clearly distinguished by several sharply-defined characters without any intermediate grades connecting them, and I have examined hundreds of each to satisfy myself of their perfect distinctness, yet the ♀ imagos proceeding from these galls, and which are undoubtedly the authors of the galls, because the larva and pupa live in the central cell, and I have actually bred them from pupæ extracted from the central cell, are undistinguishable when placed side by side, except by a slight difference in size, though the average number and structure of the joints of the ♂ antenna may possibly be different. The larvæ, too, are alike even when placed side by side; the pupæ are precisely alike, even when placed side by side, and the only characters, that I can discover, to distinguish the two species are their size, their widely distinct galls, and the fact that the pupal cocoon of the first is about 2½—3 times as long as the mature larva, and the pupal cocoon of the second is from ½ as long again to twice as long as the mature larva. Whence we may draw the general conclusion, that in order to separate satisfactorily what are undoubtedly distinct species of *Cecidomyia*, it is necessary to study them, not only in the imago state, but also in all their preparatory states, and to describe the galls with the greatest precision.

On reviewing the value of the characters to be drawn from all these sources, with especial reference to the Gall-gnats of the Willow, which are the only ones that I have carefully studied, I have arrived at the following results:—1st. The egg in all species where I have observed it is uniform in shape, being constructed precisely as Osten Sacken describes it, but instead of being "orange-yellow or whitish" it is always sanguineous, (*Dipt. N. A.* p. 180) Hence it appears that the egg

does not vary in the same species in the Gall-gnats of the Willow, but on the other hand it does not differ in different species, except of course in its proportional size; so that it is of no service here towards distinguishing species. 2nd. The larva varies very considerably in its coloration, and becomes more deeply colored after it has reached maturity and formed its cocoon, as it approaches the period when it tranforms into the pupa state; but the "breast-bone" (See *Dipt. N. A.* p. 182,) is tolerably constant in the same species. Unfortunately, however, this last character does not differ materially, there being only two distinct forms, the Y-shaped, varying in the same species by a considerable curtailment or prolongation of the lower (or posterior) arm of the Y and the clove-shaped breast-bone. I thought at first that this curtailment or prolongation might be due to the greater or less degree in which the joint bearing the breast-bone is overlapped by the following joint; but on carefully examining at the same hour 26 larvæ belonging to 5 different but closely allied species, and distending the fore part of their bodies by pressure so as to obviate any such overlapping, I satisfied myself that it was a *bona fide* variation, and that it occurs in at least 4 out of the 5 species. The comparative length and breadth of the larva is somewhat inconstant; for although *C. s. siliqua* n. sp. (?) is always, so far as I have observed, (9 specimens) elongate, yet others (e. g. *C. s. brassicoides* n. sp. and *C. s. strobiloides* n. sp.) are generally short, but occasionally as elongate as *C. s. siliqua*. *3rd.* The pupa varies very considerably in coloration, becoming much darker before it transforms. On the other hand the coloration of the empty pupal integument is very constant, and presents a few very remarkable differences in different species, even when the pupæ themselves are undistinguishable in their coloration. The characters drawn from the structure of the horns at the base of the antennæ and the thoracic bristle (*ibid.* p. 185–6) are invariable, but do not differ much in different species, no less than five species being precisely identical in these respects. It is remarkable that I could not find in any species the bristle behind the base of the antenna, which is stated by Osten Sacken to occur in most Cecidomyide pupæ. *4th.* The structure, shape and comparative dimensions of the cocoon, which the larva of most species constructs in the autumn, and in which it lies through the winter, not transforming into the pupa till a few weeks before it is ready to assume the imago state in the follow-

ing spring, afford some pretty good characters. Although there is nearly as much room for a long cocoon in the gall *S. brassicoides* as in the gall *S. strobiloides*, yet in the former the cocoon invariably envelops the larva so tightly that it is difficult to be detached, and in the latter it is invariably about long enough to hold three larvæ packed lengthways, the larva of this and other allied species being always found lying in the basal end of the cocoon with its head towards the empty tip. *5th.* As already stated, the coloration of the imago varies astonishingly, not only in the dried, but also in the living specimen, as will be shown in detail in the case of almost every species where I have obtained the imago. In the case of the abdomen ♀, the more or less deep sanguineous color is due to the color of the included eggs showing more or less through the more or less transparent integument, as is also the egg-yellow color in the abdomen of many ♀ Ephemerina. (See my Paper *Proc. Ac. Nat. Sc. Phil.*, Sep. 1862, pp. 374, 375, 377.) When these eggs are partially extruded, it will be seen that in the inquilinous *Cec. albovittata* n. sp. the abdomen, instead of fulvous or sanguineous, becomes in the empty part luteous like the abdomen of the ♂. A precisely similar thing occurs in the abdomen of many ♀ Ephemerina. (*Ibid.*) In a few ♀ *Cecidomyia*, when dried—and I have noticed the same thing in many living ♀ ♀—several eggs remain still attached to the oviduct, and I suspect that the "two small oval lamels," stated by Winnertz to be attached to the oviduct of the European *C.* (*diplosis*) *pini* DeG., are nothing but two eggs thus protruding. (*Dipt. N. A.* pp. 177–8.) On the other hand the color of the hairs of the thorax, but not of the abdomen, I find to be a constant character both in the living and the dried specimen, and to differ in some species; and the same is true of the arrangement of the hairs on the thorax, whether in rows or irregularly scattered. As regards other structural characters, the length of the oviduct varies greatly, according to the degree in which it is retracted, as has been observed by Say, (*Say's Works*, II. p. 5,) but the average length differs considerably in some few species. The number of joints in the ♂ antenna varies by 2, or 3, or perhaps even 4 joints in the same species, according to the general rule in Natural History, that multiple parts, like the vertebræ of a snake and the stamens of polyandrous flowers, are inconstant in number.* Specimens not unfrequently

*Most Coleoptera have 11-jointed antennæ, and the number of joints is inva-

occur where the right and left antenna of the same individual ♂ vary by one joint, as has been noticed by Loew of *C. chrysopsidis* Lw. (*Dipt. N. A.* p. 204.) Similarly, the ♂ antenna of *C. solidaginis* Lw. is described by Loew, probably from only a few specimens, as 22 or 23-jointed, (2+20 or 2+21,) but in one ♂ which I bred myself of that species it is distinctly 20-jointed, (2+18,) thus showing a variation of 2 or 3 joints; and, according to Mr. Herrick, the number of joints in the antenna of the Hessian fly (*C. destructor* Say) varies from 16 to 19 or 2+14 to 2+17. (Harr. *Inj. Ins.* p. 570.) To avoid ambiguity, it may be stated here that in the Gall-gnats the long basal joint or *scapus* is counted as two joints, from the homology of allied families, though to the eye but one joint is discoverable. As to the joints of the ♀ antenna, I have found it impossible to count them with any precision either in the recent or the dried specimen, owing to their being so short and towards the tip so nearly cylindrical. On the other hand the structure of the ♂ antenna, as regards the comparative length of the pedicels and verticils, is very constant; but unfortunately it does not differ at all in the different species that form galls on our willows, though in other species, e. g. *C. solidaginis* Lw., it differs considerably; and the same may be said of the neuration, with the single exception of the structure of the anterior branch of the 3rd longitudinal vein, which differs a little in some few species, the differences being nearly constant. It may be worth while here to remind the student of the very necessary caution given by Osten Sacken, "not to mistake for a vein a longitudinal fold which generally exists between the 2nd and 3rd longitudinal veins." (*Dipt. N. A.* p. 175, note.) This fold is exceedingly puzzling at first, and seems to foreshadow the interpolated vein between the 2nd and 3rd longitudinals, which occurs either simple or forked in the second Section of *Cecidomyidæ, Anaretina*. Even Westwood has been apparently deceived by its simulating a vein so completely, for he figures it along with the true veins. (*Intr.* II. p. 518, fig. 3, and compare *Dipt. N. A.* p. 174, figs. 1—5.) The ♂ genitals may, and I think do, afford some good specific characters; but these characters are almost microscopic, difficult to describe without good figures, and become evanescent in the

riable; but in ♂ *Prionus imbricornis* Lin., which has an anomalously large number of antennal joints, the number varies, even in the right and left antenna of the same individual, from 18 to 19.

dried specimen. On the whole, I know scarcely a single group of Insects, not even excepting *Aphidæ*, where the imago affords so few good and reliable characters as in the *Cecidomyia* of the willow, which is the more provoking as the number of species is so considerable. *6th.* The galls most of them afford very good, constant, and definite characters, and as yet I have found no two galls undoubtedly distinct, that cannot be sharply and effectually separated, with the exception of the Tenthredinidous galls, *S. ovum* n. sp. and *S. ovulum* n. sp., which occur on two different willows.

Osten Sacken has said that all the larvæ of *Cecidomyidæ* have 13-jointed bodies, the supernumerary joint, which bears the breast-bone, being placed between the head and the 1st thoracic (stigma-bearing) segment; and that the number and position of the stigmata are normal, one pair on the 1st thoracic segment and eight pairs on the first eight abdominal segments. (*Dipt. N. A.* pp. 181–2.) I agree with Schaum, that, contrary to the opinion of Westwood, no insect in any of its states has, in reality, more than 12 joints to the body, i. e. 3 thoracic and 9 abdominal, and I can discern but 12 joints, exclusive of the head, in the larva of any of the *Cecidomyia* of the Willow, the first joint bearing the breast-bone on its inferior surface and dorsally rather short, the last composed of little else but two tubercles transversely arranged and directed backwards. And it appears to me, (though of this I would not be so certain,) that in a very elongate and large larva (*C. s. siliqua* n. sp.?) where the joints were unusually hunched and distinct, there was a pair of spiracles to every joint but the one that bears the breast-bone and the 12th or anal one, all arranged in a lateral row $\frac{1}{3}$ of the way to the hind end of each joint. In any case there was certainly a pair of spiracles on what I consider as the 1st abdominal joint, but what, according to Osten Sacken, is the metathorax. In two or three other specimens belonging to the same species I was unable to see the spiracles so distinctly, but still I saw them.

Latreille, Audouin, Schaum, and many other European entomologists, have asserted that no insect in any of its states has any metathoracic spiracle. Loew, however, agrees with Westwood in considering the spiracle in front of the Dipterous halteres, which the above authors, most incongruously as it seems to me, maintain to be abdominal, as truly metathoracic. (*Dipt. N. A.* Intr. p. xiv.) In the larvæ of insects

which have a quiescent pupa, it is undoubtedly the general rule, that they have only one pair of thoracic spiracles, which is situated on the prothorax, or immediately behind it, or sometimes on the anterior part of the mesothorax (*Elateridæ*.) But still there are plenty of them which have both meso- and meta-thoracic spiracles. As I purpose entering fully on this and certain allied subjects in a future Paper, it will be sufficient to refer here, in confirmation of this last point, to Westw. *Introd.* I. p. 67, fig. 8, and compare p. 68; p. 255. II. p. 239. fig. 5; p. 252; p. 263, fig. 9; p. 267, fig. 15.

Osten Sacken has said, that "the use and homology of the breast-bone is unknown," and suggests that it may possibly represent the mentum of the larva of *Tipulariæ*. (*Dipt. N. A.* p. 182.) Say, from his description of this part in the larva of *Cec. destructor*, appears to have considered it as a pair of rudimentary legs, which it can scarcely be, because it is one solid piece; and besides, there is no instance in Insecta of the development of only a single pair, or of only two pair of legs, though in the larva of *Passalus* (Coleoptera) the hind pair of legs are greatly reduced in size, and functionally impotent.* and in the imagos of many Butterflies the same thing occurs in the front legs. (*Say's Works*, II. p. 5.) From the fact that in many species, especially those where it assumes a Y-shaped form, it is manifestly overlaid by the transparent integument of the insect, as may be seen from viewing it in different lights, I infer that it is not any part of the external skeleton, and cannot, therefore, be homologous with the central piece of the sternum in the imago, or the mentum in the larva of *Tipulariæ;* and that it must consequently be the homologue of some internal organ, perhaps the "antecoxal plates" of Coleoptera. (Lec. *Intr. Col.* p. xv.) From the fact stated by Osten Sacken, and which I can confirm from my own observation, that this organ is peculiar to the larva of *Cecidomyidæ*, and from the further facts that its anterior extremity, as stated by the same author, either bears one or two thorns or is serrated, &c., (*Dipt. N. A.* p. 182,) and that when the head is retracted, as is usual in the

*I state this of my own knowledge of *P. cornutus* Fabr. A larva of *Passalus* was represented with only four legs by Abbot, apparently from overlooking the hind legs, which are decussated on the sternum and not very obvious. (See Westw. *Intr.* I. p. 189.)

quiescent specimen, it projects a little from the anterior extremity of the body, I infer that its use is to abrade the interior of the gall, and, by the irritation thereby produced, promote the growth of the gall and cause a flow of sap which is to form the food of the larva. As no solid fæces are found in the cells of Cecidomyidous larvæ, it is evident that those larvæ cannot devour the solid substance of the gall, and their mouths seem entirely too soft and membranous to produce any material abrasion in the interior of some of the more woody galls e. g. *S. siliqua*. In confirmation of the above idea, it may be stated that I found in November a single larva of *C. s. strobiloides* n. sp., with one of the thorns of its Y-shaped breast-bone absent, and apparently broken off short at the bifurcation. The breast-bone can scarcely be used for locomotive purposes, as Osten Sacken doubtingly suggests; for if it were, we should surely find it in other Dipterous larvæ besides those of the Gall-gnats. Whatever be its use, it must be something specially connected with the habits of the Gall-gnats, otherwise we should find it elsewhere. In the larva of another widely distinct Dipterous gall-maker, *Trypeta solidaginis* Fitch, there exists no such organ, but the mouth terminates in a robust, horny, black, emarginate piece, which probably subserves the same purpose that I believe to be subserved by the breast-bone of the larva of the Gall-gnats.

As to the pupal cocoon of *Cecidomyia*, Winnertz, as quoted by Osten Sacken, "positively denies that the larvæ *spin* this cocoon; according to his observation, the latter is, so to say, *exuded* by the larva. He found that larvæ, which had fastened themselves to a leaf, were encircled within twenty-four hours by a white halo, consisting of tiny, thread-like particles, which seemed to grow somewhat like crystal-needles; the larva during this time remained perfectly motionless. The cocoon is perfected within a few days, and even then, under a strong magnifying power, no genuine thread is perceptible." (*Dipt. N. A.* p 184.) I believe that it is in this manner that the pupal cocoon of ALL *Cecidomyia* is formed, i. e. that it is not spun by the larva, but secreted in a glutinous form from the general surface of its body. I have observed that the thin, filmy cocoon of such species of Willow Gall-gnats, as reside in a gall composed internally of the closely appressed and overlapping leaves of the deformed bud, (*C. s. brassicoides* n. sp., *C. s. strobiloides* n. sp., *C. s. rhodoides* n. sp. and *C. s. gnaphalioides* n. sp.) is almost

always indissolubly agglutinated, especially towards its base, where the external air has not so much chance to dry it, to one or more of the small linear-lanceolate leaves that form the interior of the gall. I have also observed that the cell in which the immature larva of *C. s. batatas* n. sp. resides—the gall itself being composed of a homogeneous, rather compact, spongy substance—is (July 30) rough, opaque and scaly on its internal surface, while the cell of the mature larva for many months before it assumes the pupa state (November 11 and subsequently) is glabrous and polished, without any distinct cocoon as in the other species. To what can we attribute this change, but to the exudation of some glutinous substance by the larva, with which it, as it were, plasters the rough walls of its house? If the cocoon of *Cecidomyia* was always spun by the mouth of the larva, as most hymenopterous and lepidopterous cocoons are constructed, it would surely here assume the ordinary form of such cocoons when spun inside the walls of a cell, i. e. an integument distinct from the walls of the cell; whereas the smooth internal surface of the cell is intimately united to the original rough surface, and can no more be detached from it than the finishing coat of plaster can be detached from the first rough coat. I have observed a similar smooth lining to the cell-walls of *Lasioptera solidaginis* O. S., which, like those of *C. s. batatas*, are surrounded by brown sponge. As a proof that the smooth internal surface of the gall-cell of *C. s. batatas* is homologous with the filmy cocoon of *C. s. brassicoides*, &c., we find in *C. s. siliqua* and *C. s. cornu* n. sp. an intermediate grade between the two, viz: the central and generally the lower portion of the cocoon almost indissolubly plastered on to the smooth walls of the cell, and the upper and sometimes also the lower end forming a thin, filmy diaphragm, of precisely the same texture as the entire cocoon of *C. s. brassicoides*, &c., across the mouth and sometimes the lower end also of the cell.

From not sufficiently attending to the peculiar nature of the above process, some authors have supposed that the pupal cocoon or "flax-seed" envelop of the Hessian fly (*Cec. destructor* Say) was nothing but the indurated "skin" of the larva, i. e. that a Nemocerous Dipteron had a coarctate metamorphosis like a Notacanthous or an Athericerous Dipteron! (See Harris *Inj. Ins.* pp. 575–7, and Fitch as quoted at length by Osten Sacken. *Dipt. N. A.* p. 204.) But both Harris, and Westwood, and several other authors, expressly state that, when the "flax-

seed" envelop is carefully opened, the included insect will he seen to be still in the larva state. (Harris, *Ibid; Dipt. N. A.* p. 185; Westw. *Intr.* II. p. 529.) Now how is it possible for the "flax-seed" envelop to be composed of the external integument, or "skin," if you choose to call it by that name, of the larva, when that larva exists in its normal condition inside the "flax-seed" envelop? To believe this, we must believe that the larva moults twiee over to pass into the pupa, once to form its pupal envelop, and once to pass into the pupa state, which is contrary to all analogy. Of one thing I am, at all events, quite certain, viz: that with the Gall-gnats of the Willow it is impossible that the cocoon can be formed of the external integument of the larva; for, not only is there an utter absence of the transverse sutures which we find in all coarctate pupæ, representing the sutures between the joints of the larva, but in several species the cocoon is 2—4 times as long as the body of the larva when that body is stretched out to its fullest extent. Moreover in two specimens of the gall *S. siliqua*, (see below No. 8,) I found *two* cocoons, one inside the other; so that if the cocoon of this species is always formed of the larval integument, the larva must, in these two cases, have moulted *twice over* to form its two cocoons; which is absurd. Osten Sacken observes that "the larva of *C. pini inopis* O. S. fastens itself to a pine leaf, and remains motionless until the resinous substance, which it exudes abundantly, begins to harden; the larva then gradually frees itself from the contact of the cocoon-like case thus formed" (*Dipt. N. A.* p. 185.) These observations are in complete harmony with the theory of Winnertz, quoted above; but when Osten Sacken adds that "it is very probable that this cocoon is nothing but the outer larva-skin, saturated with resin," I think he has been inadvertently led into error by the theories of Harris and Fitch.

I am also very skeptical as to certain assertions of Harris and Fitch, that the larva of *Cecidomyia* transforms *gradually* into the pupa state, by a kind of budding process, without moulting the larval integument, instead of *suddenly* moulting into the pupa state, as in all other insects. This theory seems to have been devised in order to harmonize with the erroneous hypothesis already referred to, (viz: that the cocoon of the Hessian fly is made out of the external integument of the larva,) and so prevent the necessity of assuming that the larva moulted twice over to pass into the pupa state. (See Harr. *Inj. Ins.* p. 577.) Thus, per-

haps, as often happens, one mistake has given birth to another, and in stopping one leak another has been opened. In the larva of the Gall-gnats there are, of course, no legs. In the pupa the legs extend to the tip of the abdomen, or even beyond it, and both legs and antennæ, as is well known to be the case with all other Nemocerous Diptera, are perfectly free and detached from the body. From repeated experiments, I know that, in the case of the Willow gall-gnats, the pupa remains in this state for a week and over, without the legs or antennæ becoming any longer, before it transforms into the imago. It is likely enough, indeed, that the legs and antennæ of the future pupa may become partially visible under the very thin, delicate, and semi-transparent integument of the larva, shortly before that integument is moulted; but still they will not then be *free*, as in the true pupa, neither will the insect be as yet in the pupa state, properly so called, for that very reason. I believe that it was from not attending to the distinction between *obtected* legs and antennæ, and *free* legs and antennæ, in two radically distinct states of the Gall-gnat, viz: the very mature larva and the true pupa states, that the above quoted assertions took their origin. I have probably examined at different times considerably over a thousand specimens of Willow Gall-gnats, some in the larva and some in the pupa state, and I always found them *either in one state or the other*. Whereas if, as Harris and Fitch assert with especial reference to a Willow Gall-gnat, the change from the larva to the pupa state was *gradually and slowly* effected, as a newly-hatched chicken gradually and slowly exchanges its hairs for feathers, I certainly must have met with at least a few specimens *in the transition state*, i. e. with legs and antennæ free but only $\frac{1}{4}$ or $\frac{1}{2}$ or $\frac{3}{4}$ as long as in the normal pupa. Authors are perpetually forgetting, that Annulate animals pass from one state to another only by suddenly moulting their skeletons, while Vertebrate animals retain the same skeleton throughout, and pass from one state to another by the slow and gradual accretion of new matter. Osten Sacken incidentally remarks that the facts referred to above are "not mentioned in the European authors." (See on this subject *Dipt. N. A.* pp. 184—5; Harris *Inj. Ins.* pp. 566—7.)

Perhaps few things have contributed so much towards propagating erroneous views on such subjects as these, as the almost universal use of the term "skin" as applied to the external integument of Insects, especially

when in their softer larval and pupal states. Hence the mind is insensibly led to suppose that there is a homology between this so-called "skin" and the true skin of the Vertebrate animals; and that the difference, for example, between the hard shell of a Coleopterous imago and the soft skin of a frog, is the same as that between the hard shell of a Coleopterous imago and the comparatively soft shell or so-called "skin" of its larva and pupa, or that between the hard shell of a tortoise or an armadillo and the soft skin of a frog or an ourang outang. Whereas the tortoise and the armadillo, equally with the frog and the ourang outang, have a distinct skeleton, to which most of their muscles are attached as in other Vertebrata, *inside* their external integument, which is, therefore, in the case of the two former animals, a true, shelly, indurated skin; while no Coleopterous imago, or pupa, or larva, or any other Annulate animal, in any of its states, has any such skeleton, all its muscles being attached to the external integument, no matter whether it is hard or soft, or of an intermediate texture, which is therefore not a true skin but a mere naked, external skeleton, protected by no skin, because, unlike the soft external muscles of the Vertebrata, it does not require any such protection. "Articulorum nexibus," says the great Father of modern Scientific Entomology, speaking more particularly of Crustacea, "*externis*, nec productione *cutis* (ut in mammalibus, avibus) tectis." (Latr. *Gen. Cr. et. Ins.* I. p. 5.) No one can look at the claw-bearing legs of a crab or a lobster, or the knee-joints of the hind legs of a Cricket or Grasshopper, without being struck by the great similarity of the articulations to those which we commonly find in the skeletons of Vertebrata. Hence the miser that proposed to "skin a flea for its hide and fat" proposed a physical impossibility; for no flea, or any other Annulate animal, has got *any hide at all*. More fortunate than the Student of Vertebrata, the Entomologist is not compelled to go through the tedious process, with his specimens, of dissecting away the skin and the muscles, boiling down the bones, and then putting them together again by artificial appliances, before he can get a complete view of the skeleton of the animal which he is studying; but Nature furnishes him with *his* skeletons in the most bountiful profusion, uneoncealed by extraneous substances, and already set up and put together, the separate bones all fastened in their proper places by their natural membranous connections, and every part perfect and un-

injured. It is by a careful study of what is truly and correctly speaking the Skeleton of Insects. (so far as any part or organ in one Animal Sub-kingdom can be homologous and homonymous with a similar part performing similar functions in another Animal Sub-kingdom,) and of the various confluences, connations, arrangements and shapes of the bones, or "pieces," as they are commonly called, that compose it. that most of the modern improvements in the Classification of Insects have been perfected.

The question naturally recurs here, how, having by the process described above secreted this glutinous substance from the general surface of its body, the larva of *Cecidomyia* contrives to detach itself from it, so as to construct a true cocoon, enveloping its body, but not agglutinated to that body. Winnertz declares that his larvæ remained perfectly motionless during the process of the formation of their cocoon. The larva, therefore, can scarcely become detached from the glutinous matter by wriggling its body round and round, even if we could explain how an insect, by wriggling round in a drop of tar, could form of that tar a more or less thin pellicle, enveloping, but not agglutinated to itself. From the careful study of the phenomena presented by the cocoons of the Willow Gall-gnats, I have arrived at the conclusion, that after secreting the glutinous matter from the general surface of their bodies, they must then discharge something of a gaseous nature, probably from the same pores which secreted the glutinous matter, so as to detach the adhesive material from their external integument and blow it up into a kind of bubble. We know that the imago of the Coleopterous *Brachinus* has the power of discharging a very acrid gas from its anus, and that most plant-feeding Heteroptera in all their states discharge a fetid gas from a large opening like a spiracle on the inferior surface of their bodies. When in a particular species of *Cecidomyia* the quantity of gas is small, then the cocoon is small, and fits pretty closely to the body of the larva, as in the well-known Hessian fly and *Cec. s. brassicoides* n. sp. When on the other hand, in another species, the quantity of gas is large, then the cocoon is large as in *Cec. s. strobiloides* n. sp. and its allies. When it is so large that it retains sufficient expansive force to press the cocoon firmly against the walls of the cell, and those walls are adapted to adhere to a glutinous substance, then the cocoon is firmly agglutinated to them, except at the elon-

gate, slender tip of the cell, where, the air having free access to it, it dries rapidly, so as to form a subterminal diaphragm across the mouth of the cell, as in *C. s. siliqua* n. sp. and *C. s. cornu* n. sp. When its expansive force is lost before the walls of the cell are reached, or when the walls of the cell are not adapted to adhere to a glutinous substance, or when, from the free admission of air, the glutinous matter dries too rapidly to have time to adhere, then the cocoon remains separate and distinct from the walls of the cell, as in *C. s. triticoides* n. sp., or adheres to it only here and there, as in *C. s. strobiloides*, &c. The fact just now referred to of there being a *double* diaphragm formed by the thin pellicle of the cocoon at *both* ends of the cell in two specimens of the gall *S. siliqua* found on S. cordata, seemed at first sight opposed to the above hypothesis; but we may get over the difficulty by supposing some abnormal affection of the larva, so that its gas began to be discharged before it had done secreting its glutinous matter, and that it thus formed two cocoons one after the other, and one inside the other. In any case, no matter how the cocoon was formed, there must have been here two separate cocoons formed one after the other, and one within the other; and the fact of the exterior one of the two not having extended to the base of the cell, as it invariably did in scores of other specimens examined by me, proves that when it was formed there must have been a scant supply of material. On the whole, it is impossible to look at the thin, filmy cocoons of *C. s. strobiloides* and its allies, which are not thicker here and thinner there, but of one uniform, homogeneous thinness, without being impressed by the idea that they are mere bubbles, blown by some wonderful and hitherto undreamt of process within the lanceolate cell in which the animal resides. A larva might spin such a homogeneous cocoon with its mouth, as many Hymenopterous cocoons of nearly as great tenuity and equally homogeneous are spun, e. g. that of *Pelopæus lunatus* Fabr.; but it is, I think, proved that the cocoon of the Gall-gnats is exuded and not spun. It must, therefore, be either blown like a bubble or be daubed on the walls of the cell by the body of the insect. But no mere smearing and daubing process could spread that mortar in such a regular manner, as to be precisely of the same tenuity, where it forms a diaphragm across the upper end of the lanceolate cell, as in *C. s. strobiloides*, &c., that it maintains everywhere else. Consequently it must be blown like a bubble.

Be this as it may, one thing is quite clear. It is impossible that, in one and the same genus of insects, some species, as Harris believed, should spin a silken cocoon and transform into the pupa state inside that cocoon, without moulting any larval integument, by a certain anomalous budding process, and that other species should spin no cocoon, become detached from the larval integument without ceasing to be still larvæ, and then transform inside that detached larval integument by the same budding process as the others. It is undoubtedly true, for I have verified the fact myself, that some *Coccinellidæ* transform to pupa inside the larval integument, and some moult it in the normal manner; this is anomalous enough, but it is not so utterly anomalous as the Harrisian theory.* But the climax is reached, when it is proved by the observations of Winnertz and Osten Sacken, that several other species of the same genus *exude* their cocoons from the general surface of their bodies, thus giving three totally different methods of forming the pupal envelop in the same genus—spinning, moulting and exuding!!! It is very true that the pupal envelop, in the Hessian Fly and in the Gall-gnats that exude their cocoons, is much more dense and leathery than in the Gall-gnats of the Willow and in the Wheat-midge; but that is merely a question of mode and degree, not of principle, and is probably due to the fact, that in the Gall-gnats of the Willow the pupa is completely protected by a dense mass either of wood or leaves, and does not therefore require a robust cocoon, while the Wheat-midge ordinarily goes under ground to assume the pupa state, though a few transform in the ear of the wheat. That

* In *Chilocorus*, as stated by Westwood and as I have myself observed In *C. bivulnerus* Muls., the larval integument is retained *whole* by the pupa; in the European *Coccinella Argus* it is retained, but *widely split open along the back*, thus showing an intermediate grade between the anomalous transformation of *Chilocorus* and the normal transformation of most other *Coccinellidæ*. (Westw. *Intr.* pp. 397—8.) But there can be no possible intermediate grade between a cocoon spun by the mouth of a larva, and the puparium of a true coarctate pupa, which is formed out of the indurated integument of the larva, the two things being radically and fundamentally distinct. In *Anthrenus* (*Dermestidæ*), which also retains the larval integument when it transforms to pupa, there is a similar slit made along the back of it; but whether this is also the case in other Dermestide genera which retain the larval integument when they transform to pupa, (*Megatoma* and *Tiresias*,) is not stated. (See Westw. *Intr.* pp. 159, 161.)

the pupal envelop of all *Cecidomyia* is formed in the same way, and that the resinous envelop of *C. pini inopis* O. S. and of the *Cecidomyia* referred to by Winnertz is strictly homologous with the "flax-seed" envelop of the Hessian fly, and both of them strictly homologous with the smooth lining of the cell-walls of *C. s. batatas* n. sp. and the thin, filmy cocoon of the Wheat-midge, (*Cec. tritici*,) and of several of the Gall-gnats of the Willow, I have no manner of doubt. Now we know that in the first case the pupal cocoon is exuded. Whence it is but rational to believe, in opposition to the theories of Harris and Fitch, that in all the other cases the pupal envelop is likewise exuded, and not spun nor formed out of the moulted integument of the larva.

As to the Natural History of the Wheat-midge, when that insect, as is occasionally the case, transforms to pupa in the ear of the wheat, it forms a thin, filmy cocoon and generally transforms to imago the same season. (Marsham and Kirby, quoted Harris *Inj. Ins.* p. 589.) Those that go underground to transform must undoubtedly also form a cocoon; and from the analogy of the Willow Gall-gnats we may conclude, that they ordinarily lie in the cocoon in the larva state all through the winter, and at least until the commencement of the following spring, the imago appearing in June and July, and the imago of most of the Willow Gall-gnats appearing as early as April and May. There is a similar variation in the habits of the European Willow Gall-gnat, *C. terminalis* Lw., which, according to Winnertz, "sometimes goes under ground, and sometimes transforms within the willow leaves deformed by it." (*Dipt. N. A.* p. 184.) Harris, singularly enough, while he holds that the thin, delicate cocoon of the only Willow Gall-gnat known to him is *spun* by that insect, maintains, contrary to the opinion of Kirby and my departed botanical friend, Prof. Henslow of Cambridge, England, that the similarly thin and delicate cocoon of the Wheat-midge is, equally with the dense, leathery cocoon of the Hessian Fly, composed of "the outer skin of the larva." (*Inj. Ins.* pp. 590, 596.) He appears to have been led into this belief, in regard both to the Hessian Fly and the Wheat-midge, from observing in the cocoon of both of them faint indications of the same transverse sutures that we see in the coarctate pupa of *Stratiomys* and *Musca*. (*Ibid.* pp. 576, 595.) Such phenomena are easily explainable on the theory of the cocoon being *exuded*, but he very justly considered that they were opposed to the theory of

the cocoon being *spun*. Having once become firmly possessed by this notion, he implicitly accepts and adopts the statement of a lady, that she saw "many of the *maggots* [of the wheat-midge] in the very act of emerging from their skins" [cocoons], and makes confusion worse confounded, by maintaining that the larva of that insect first of all constructs a house for itself by sloughing off its entire "skin" like the Hessian Fly, and then, unlike the Hessian Fly, crawls out of that house and goes underground naked to transform to pupa! (*Ibid.* pp. 595—8.) It must have been, not the *maggot* (larva), but the *pupa*, that the lady saw emerging in the summer from what she called its "skin," but what is in reality its cocoon, thin and filmy indeed, but no more so than those of the Willow Gall-gnats, and enveloping the larva closely as in *C. s. brassicoides*. (Marsh. and Kby.) And the "silvery coverings glistening in the sunshine on the ears of the wheat" so graphically described by the same lady, (*ibid.* p. 597,) are manifestly not the "*skins*," as Harris believed, of the larvæ that had gone underground for the winter, but the *cocoons* of the comparatively few individuals that remain throughout in the ear of the wheat and *transform to imago the same season;* as observed by Marsham and Kirby, and as occurs in many insects belonging to other Orders, e. g. the Canker-worm (*Anisopteryx vernata* Peck) and *Acromycta oblinita* Guén. (Walsh, *Trans. Ill. St. Agr. Soc.* IV. p. 358.) In scientific matters, to get at the truth from amidst the confused and contradictory evidence of non-scientific observers, often requires the abilities of a first-class Philadelphia lawyer. Harris, indeed, states, as of his own knowledge, that "not the slightest vestige of the larva-skin [cocoon] was found in the earth in which some of these insects had undergone their transformations," and that "the pupa is entirely naked." (*Ibid.* pp. 597–8.) But this may be readily accounted for on the hypothesis, that when the larva goes underground the excessively thin cocoon, being glutinous when it is newly exuded and not drying rapidly in the moist earth, adheres strongly and becomes indissolubly agglutinated to the dense medium that surrounds it, as does the cocoon of *C. s. batatas* n. sp. to the surrounding moist, dense, spongy matter of the gall of that insect; whereas, when the same cocoon is exuded by the same larva among the loose chaff of the wheat-ear, it dries rapidly and is not so agglutinated. It has been already stated that in *C. s. cornu* n. sp. and *C. s. siliqua* n. sp.? part of the thin, filmy cocoon adheres strongly to the surrounding medium and part does not.

There is a very prevalent idea in the Agricultural community, that all that is required, in order to devise remedies for the depredations of any given Noxious Insect, is to investigate the Natural History of that one given Insect. The cases of the Hessian Fly and the Wheat Midge —two insects which annually damage the people of the United States to the extent of at least a hundred million dollars—prove, I think, satisfactorily, that it is impossible completely to unravel the intricacies of the Natural History of certain Noxious Insects, unless we first become well acquainted with the Natural History of their congeners. As well might we attempt to delineate the path of a Comet, without first becoming acquainted with the laws that regulate and control the whole Solar System. Without such collateral knowledge, we shall sometimes—instead of recognizing that UNITY OF HABITS in every genus, which is the very essence of the thing that we call a Genus, because Habits are correlated with Structure, and Structure makes the Genus—become prone to believe in the existence of several fundamentally different and heterogeneous habits in one and the same genus, we shall be liable to accept as indisputably true the most absurd and contradictory and anomalous statements from others, and we shall ourselves be led into errors and hallucinations without number, and in these minute objects be occasionally deceived by optical illusions and phenomena which exist only in the imagination.

"The observer," says Osten Sacken, "must see well and *render only what he has seen;* a condition much more difficult to comply with, in matters of Natural History especially, than is usually imagined." (*Proc. Ent. Soc. Phil.* I. p. 47.) "It is well," says the English conchologist, Dr. P. P. Carpenter, "in the present state of science, to TAKE NOTHING ON TRUST. What is copied from book to book, and what is repeated from figure to figure, may be correct; but then on the other hand it may not. * * It is curious how large a proportion of existing observations on Mollusks need verification by those who have honest, well-trained eyes. Just as the infant's eye has to be trained to distinguish forms and distances, so it requires practice, before we know how to see truly an object that lies before us. During the educational process, *it is often very easy to see what we wish or expect to see.*" (*Rep. Smithson. Inst.* 1860, pp. 280, 231.) If, then, error is as rife in Science as the above observations would lead us to suppose, surely the

refutation of Old Error is at least as important an occupation for the naturalist as the exposition of New Truth. Otherwise, if we all busy ourselves in the publication of what each of us considers as new truths, and nobody takes the pains to winnow away the falsehoods from the enormous mass of observations accumulated by his predecessors, Science soon becomes a mere heap of chaff with only a few kernels of wheat mixed in amongst it. I know no entomologist, living or dead, who has not made some grievous mistakes; and I candidly confess that I have myself made several most inexcusable ones. The difference between the pretentious charlatan and the truly scientific entomologist is, that the former claims to be infallible and invariably gets angry when his errors are refuted and corrected; the latter always acknowledges and corrects his own errors when he is fortunate enough to discover them himself, and is thankful to any one else who will take the trouble to correct them for him. The former writes and talks for victory and not for truth; the latter for truth and not for victory. "By their fruits ye shall know them."

Thus far we have been dealing with natural phenomena. We now approach a subject which may be considered as verging almost upon the supernatural and the miraculous. If we can believe what is asserted by a Russian naturalist, the larvæ of *Cecidomyia* differ, not only from the larvæ of all other known insects, but from all known animals, no matter to what Class they belong, in propagating their species while they are still in the larva or immature state. I am indebted to Baron Osten Sacken for furnishing me with the following account of this most astounding revelation;—

About a year ago Wagner, a Russian naturalist and a good anatomist, published a large folio work in the Russian language, illustrated by numerous plates, relative to certain observations which he had made on *Cecidomyia*. He asserts that some larvæ of this genus, which he found under the bark of trees in winter, *breed young ones!* In other words, that during winter a second generation of larvæ is developed within the bodies of the first, that having reached a certain stage of growth these larvæ leave the bodies of the mother larvæ (several from each), and that they grow and afterwards produce a third generation in the same manner. This goes on till spring, when the last generation is transformed into flies. Thus the reproduction of these *Cecidomyia* would have some analogy with that of *Aphis*. A mother larva usually, he says, generates from 7 to 10 young larvæ, and at a certain stage of their growth she becomes half-dead and hardly moves, and finally dies, when the young larvæ

creep out. The development of the latter within the body of the mother lasts 8 or 10 days. After 3 or 5 days the same process is repeated within the body of the young larvæ. His statements and drawings are so precise and detailed, that it is difficult to discredit them. Nevertheless the novelty of the discovery (if it is one) is so overwhelming, that it is not generally credited yet. He does not explicitly mention, that his larvæ of the second and third generation have the "breast-bone" peculiar to *Cecidomyia*, but it follows indirectly from his statements.

There is no doubt whatever in my mind, that the 7 or 10 young larvæ that crept out of the body of the *Cecidomyia* larva, were nothing but the larvæ of *Chalcididæ* or *Proctotrupidæ*, several species of which I know from experience to breed in about those numbers inside the bodies of the larvæ of Willow *Cecidomyia*. The description of the mother larva being "half-dead and hardly moving," before they crept out, is to the life, and represents exactly what every breeder of Insects has witnessed a dozen times in the case of ichneumonized larvæ. As to Wagner's statement that these same newly-born larvæ went through the same process a second time, I cannot but believe that it is a pure and simple delusion. If I had found that the Gall-gnats of the Willow were ever infested by Ichneumon-flies or Tachina-flies, I should suppose the above to be a mere case of Secondary Parasites coming out of the bodies of Primary Parasites. But, so far as my experience extends, they are infested only by *Chalcididæ* and *Proctotrupidæ*. Now in 11 published cases of Secondary Parasites that I am acquainted with, two of which I have myself published, and in several unpublished cases that are known to me, the Primary Parasite is, in every one of them, either an Ichneumon-fly or a Tachina-fly, and never a Chalcidide or a Proctotrupide. Whence I conclude that there are most probably no Secondary Parasites that infest the genus *Cecidomyia*, because, if there were, they must in all probability, contrary to what seems to be a general rule, be parasitic on a Chalcidide or a Proctotrupide. We are not bound, however, to believe every erroneous or anomalous statement, until we can show how and why the error originated. When, as here, a supposed fact violates a law that prevails throughout Vertebrata and Annulata, and perhaps throughout the whole Animal Kingdom, viz: that it is only the adult animal that propagates its species, the *onus probandi* lies on the asserter of the fact, and not on the rest of the Scientific World. It is contrary to experience that lambs, and calves, and

babies, and tadpoles, and larvæ, should propagate their species, but it is not at all contrary to experience that human eyes should be deceived. The well-known case of *Aphis* is not a case in point. It is not the *larva* of the *Aphis* that generates by parthenogenesis, but an adult, although wingless, dimorphous form of the winged imago of the ♀ Aphis. The whole question hinges entirely upon the presence of the "breast-bone" in these young larvæ, which Wagner asserts were produced from the bodies of *Cecidomyia* larvæ. If they had that "breast-bone," they were *Cecidomyia;* if they had not, they were beyond all question *Chalcididæ* or *Proctotrupidæ*. Yet, important as this point is, Wagner does not appear to have paid enough attention to it, to think it worth while to testify explicitly on the subject!

Since the above was written, Baron Osten Sacken has been kind enough to inform me that "Wagner's discovery is now very well known in Germany, and has been fully confirmed by several observers." What is the entomological status of those observers, and how far their evidence is trustworthy, is not specified. They may be scientific tyros, or they may be good general Naturalists but very poor Entomologists, or they may be men of high standing and credit in the entomological world. For my own part, I would not believe in an anomaly which not only contradicts the known generative economy of all Vertebrate and Annulate Animals, but which also runs counter to what I know, from close and long continued observation, to be the generative economy of several other species of the same genus, viz: the Gall-gnats of the Willow, unless I saw it at least a dozen times with my own eyes, or unless it was vouched for by at least a dozen good and experienced Entomologists. It is utterly incredible that certain species of *Cecidomyia* should procreate in the larva state, while certain other species procreate in the normal manner. Now I know that the *Cecidomyia* of the Willow procreate in the normal manner; and therefore, firmly believe that all other *Cecidomyia* procreate in that manner. To believe to the contrary seems to me to require as much faith as to believe that certain Species of the genus Felis are viviparous, and certain other species of the same genus lay eggs and hatch them out like a bird; or, that certain Gallinaceous birds feed, when first hatched out, upon vegetable substances, and certain others suck the teats of their mothers like so many Mammals.

The Russian naturalist, however, and the unnamed German observers

are by no means the first men that have been similarly deceived by parasitic insects. Some years ago one of the most celebrated of our Western *Savans* announced in print, as a great scientific discovery, that he had ascertained that Army-worms (*Leucania unipuncta* Haw.) were viviparous, and that they generated in precisely the same manner as Wagner supposed that *Cecidomyia* generated, i. e. in the larva or baby state. There can be no doubt, that what he took for young Army-worms issuing out of the bodies of their mothers were simply the larvæ of Ichneumon-flies—probably *Microgaster militaris* Walsh or *Pezomachus minimus* Walsh, which I have myself bred from Army-worms. But the mistake was the more inexcusable on his part, because if he had simply looked at one of his so-called young Army-worms with his naked eye, he would have seen at once, that, unlike the mother-insect, it had *no legs at all;* and if he had known anything at all of Lepidopterous larvæ, he would have known that they had just as many legs when they first hatched out, as when they were full-grown. On the other hand, in Wagner's case, both the so-called mother larvæ and the young larvæ were apod, and putting the "breast-bone" out of the question, it requires practiced eyes and close scrutiny to distinguish the larva of a Gall-gnat from that of a Chalcidide, or from that of a Gall-fly. We saw just now (p. 551) that several distinguished European naturalists had mistaken the larva of a Gall-gnat that inhabits the "Rose-willow" for the larva of a Gall-fly; and I am not ashamed to confess that I myself formerly mistook the dried larva of another Gall-gnat for the larva of a Gall-fly. (*Proc. Ent. Soc. Phil.* II. p. 481–2.)

Like most gall-insects, and even more so than most of them, the Gall-gnats are difficult to rear in the house. The reason is obvious. When the connection between the gall and its parent plant is severed, it is almost impossible to devise any artificial mode of treatment, which shall supply the place of the natural flow of moisture from the part of the plant on which it formerly grew. Of the eight new Cecidomyidous galls on the Hickory described by Osten Sacken, (*Dipt. N. A.* pp. 191—4) he obtained the imago from but a single one. Of the fifteen new Cecidomyidous galls on the Willow which I now describe, I have obtained the imago from all but nine, and one of these nine is a species which does not grow near Rock Island. The method by which I achieved these results was to replace the galls in the breeding-jar, whenever

practicable, every four or five weeks by freshly gathered ones; which, as most Willow-galls are exceedingly abundant, is not a matter of much trouble or difficulty.

In the following Synoptical Tables I have endeavored to separate, by constant and sharply-defined characters, drawn from every available source, the fifteen species of Cecidomyia known by me to form galls on the Willow. After this, each gall and its gall-maker in all its states will be described so far as known to me, chiefly from recent specimens, and the whole will conclude with descriptions of all the Inquilinous *Cecidomyidæ* that are known by me to inhabit any galls of the Willow, whether Cecidomyidous or Tenthredinidous, and a list of the galls inhabited by each species, followed by a notice of a few other Diptera that occasionally or habitually breed in Willow-galls.

SYNOPSIS OF THE CECIDOMYIDOUS GALLS OF THE GENUS SALIX (WILLOW).

A. Gall always monothalamous, and evidently a deformation of a bud.

I. Bud with its leaves well developed.

1. Galls almost always many of them growing contiguously together, not usually at the tip of a twig. (Gall large, expanding .75—2.25 inch.) — 1, **S. brassicoides**, n. sp. on S. longifolia.

2. Gall always solitary, and always growing at the tip of a twig.

† Leaves of the gall all sessile.

a. External leaves appressed like the scales of a young pine-cone, and rounded at tip except near the tip of the gall, where they are angulated. (Gall large, expanding .50—.90 inch.) — 2, **S. strobiloides** O. S. on S. cordata.

b. External leaves appressed like the scales of a young pine-cone, and all of them angulated at tip. (Gall large, expanding about .70 inch.) — 3, **S. strobiliscus** n. sp. on S. rostrata.

c. External leaves generally opened out and recurved at tip, and always more or less beaked at tip. (Gall small, expanding .14—.60 inch.) — 4, **S. gnaphalioides** n. sp. on S. humilis.

†† Terminal leaves peduncled, the other external leaves sessile and opened out, and at tip recurved and acutely angulated. (Gall large, expanding .70—1.90 inch.) — 5, **S. rhodoides** n. sp. on S. humilis.

††† All the external leaves peduncled more or less, the terminal ones the most so, and opened out and at tip recurved, and obtusely, seldom acutely, angulated. (Gall very large, expanding 1.95—4.10 inch.) — 6, **S. coryloides** n. sp. on S. discolor?

II. Bud deformed into a long tube; its leaves obliterated. — 7, **S. cornu** n. sp. on S. humilis.

B. Gall a deformation and swelling of the twig itself.

1. Gall monothalamous, solitary, woody.

a. Gall oval, growing always at the tip of the twig, but always including several of the sub-terminal buds, which are usually aborted, the terminal one always.	8, **S. siliqua** n. sp.? on S. humilis, (S. cordata? and S. discolor?)
b. Gall generally oval, generally growing some distance from the tip of the twig and but rarely including even a single bud, occasionally at the tip, when it includes only the terminal bud, which is then more or less aborted and occasionally obliterated.	9, **S. nodulus** n. sp. on S. longifolia.

2. Gall polythalamous, woody, growing not far from the tip of the twig, each cell excavated at the origin of a bud, and opening outwards through that bud, which is deformed so as to form part of the cell.

a. Gall oval and bulging, the twig where it grows being enormously contracted in length.	10, **S. triticoides** n. sp. on S. cordata.
b. Gall cylindrical and not bulging, the twig where it grows not being very much contracted in length.	11, **S. hordeoides** n. sp. on S. humilis.

3. Gall polythalamous, more or less spongy, with its cells all internal.	12, **S. batatas** n. sp. on S. humilis, (S. cordata? and S. discolor?)

C. Gall growing out of the leaf, the shape and structure of the leaf still plainly perceptible, monothalamous, but several of them often confluent.

1. Growing sparsely from the midrib or one of the principal veins.	13, **S. verruca** n. sp. on S humilis.
2. Growing very numerously from the general surface of the leaf.	14, **S. semen** n. sp. on S. nigra.

D. Gall growing from the flower-catkins (and sometimes from the leaves?) and destroying all vestiges of their structure, so as to appear like the crumpled mass of aborted flower-buds in a common cauliflower.	15, **S. ænigma** n. sp. on S. nigra.

Putting the gall out of the question, and looking only to the insect in all its states, the species 1, 2, 4, 5 and 8, which resemble one another so closely, that several of them are undistinguishable in the imago state, not only in the dried but in the recent specimen, may be separated as follows. Nos. 3, 6 and 7 belong to the same group as 1, 2, 4 and 5, but, as they are not known to me in the imago, are necessarily omitted here. I find that certain Lepidopterists repudiate the idea, that it is possible for two species of insects, like the two *Halesidota* referred to in a previous Article, to be undistinguishable in the imago, and yet perfectly distinct in some of their other states. The study of the genus

Cecidomyia might serve a useful purpose towards dispelling that illusion.

A. Front ½ of pupal integument whitish like the abdomen. (Larva varied with yellowish or orange.)
1. Hair of thorax blackish in the imago.....No. 1, **C. s. brassicoides**, n. sp.
2. Hair of thorax whitish in the imago.
† Origin of the anterior branch of the 3rd longitudinal wing-vein obsolete.....No. 2, **C. s. strobiloides**, n. sp.
†† Origin of the anterior branch of the 3rd longitudinal wing-vein pretty distinct.
a. Cocoon 1½—2 times as long as the larva.....No. 4, **C. s. gnaphalioides**, n. sp.
b. Cocoon 2½—3 times as long as the larva.....No. 5, **C. s. rhodoides**, n. sp.

B. Front ½ of pupal integument pale dusky.* (Larva varied with sanguineous.).....No. 8, **C. s. siliqua**, n. sp. ?

GALLMAKERS.—Genus **CECIDOMYIA**, Subgenus **CECIDOMYIA**.

No. 1. **Gall Salicis brassicoides**, n. sp.—On Salix longifolia. Monothalamous, sessile galls, expanding each ¾—2¼ inch, and with the general outline of each spherical or oval, growing in a more or less close-set bunch of 1—11, like the sprouts of a cabbage-stump, on twigs which vary in diameter from .10 inch to .50 inch, sometimes from their tips but more generally from their sides, and often with several minute twigs growing from the midst of each bunch of galls, the largest galls generally on the largest twigs. The leaves composing each gall are all sessile, and are on the outside ovate-lanceolate or lanceolate, and widely expanded and towards their tips recurved. Towards the tip of the gall they become smaller, slenderer, and gradually less expanded, and in the centre they are quite small, perfectly straight and linear-lanceolate, closely embracing the central cell containing the author of the gall. External leaves with the midrib, and generally some of the branching side-veins, pretty distinct. It is but very

* It must not be supposed that this infuscation is causeless and accidental. There is a cause for every natural phenomenon, if we can only discover it: and the reason why the anterior parts of the pupal integument are in this species strongly tinged with fuscous, instead of being whitish hyaline, as in other allied species, is that they are thickened: and the reason that they are thickened is, that the pupa has to make its way out through the narrow, woody tube at the tip of its gall, instead of through soft and yielding leaves as in the case of species Nos. 1—6. In the same manner, as will be noticed below, the antennal horns of those species that have to work their way out through dense sponge or wood (*C. s. batatas* n. sp. and *Cec. cornuta* n. sp.) are thickened and blackened in the pupal integument. We must remember that the pupal integument of an Insect bears the same relation to the pupa itself, that the prepared skeleton of a Mammal bears to the Mammal itself.

rarely that the leaves composing each gall show any traces of the peculiar, widely-removed serratures which characterize the leaves of the willow on which they occur, their edges being almost invariably perfectly entire. The color of the galls when recent, is the same as that of the recent leaves of the willow on which they grow, but at the fall of the leaf they become reddish brown, and after hanging on the twig more than one year, almost black.

Described from 19 bunches of galls. Very common near Rock Island, Illinois.* The eggs that originate these galls must be laid from the middle of April to the end of May, and by the middle of July the galls have attained their full size. When the twig on which they grow is at all small, it generally dies the next spring.

Larva.—On July 31 the larva was already .03—.10 inch long, and whitish hyaline with opaque, white, curdy, bowel-like markings; breast-bone indistinct. Out of 12 specimens examined Nov. 12, all had formed their cocoon and were full-grown, being .10—.20 inch long and .05—.10 inch wide, of the usual oval form, rarely elongate so as to be 3 or 4 times as long as wide, whitish or yellowish subhyaline, with the same opaque-white markings; breast-bone distinct, dusky, robustly Y-shaped: the two prongs of the Y placed in front, basally divaricating at an internal angle of about 45°, and tapering on their external edge into a slender, acute thorn at tip, so that their external edges are nearly parallel with each other. Ordinarily the three arms of the Y are subequal in length, but occasionally the lower (or posterior) arm is shortened about ⅓, and occasionally the other two arms are similarly shortened. The lower extremity of the Y is generally squarely but obscurely truncate, but sometimes the whole lower arm tapers gradually to a point from the bifurcation downwards. The *cocoon* is whitish-hyaline, delicately thin, scarcely larger than the larva, and generally adheres laterally and especially towards its base to a few of the innermost small leaves of the gall, its base being imbedded in a shallow, cup-like cavity at the tip of the globular stem from which the leaves of the gall take their origin. In this cocoon the larva, as well as the pupa, is always found with its head towards the tip of the gall. On Feb. 20 the larvæ were more generally and more deeply yellowish, the breast-bone darker, and many of them had a broad, dorsal, dusky vitta on 3 or 4 of the middle joints. One contained 15 parasitic larvæ, showing plainly through its integument, in the manner figured by Westwood *Intr.* II. p. 167, fig. 14, which I afterwards squeezed out and counted, and April 19 I found a similar specimen containing 10 larvæ. On Feb. 20 I also found a single Proctotrupide imago inside each one of 11 or 12 cocoons, all very lively when disengaged from their own cocoon. On March 29 I found nothing but larvæ in very numerous galls which I opened, and continued to find very many larvæ up to April 21, and for some time afterwards. Those examined April 19 were more highly colored, being yellowish-

*I found, March 16, on the tips of the twigs of young, stunted, wild plum-trees, bunches of galls much resembling *S. brassicoides*, but with the cells all of them empty.

opaque, with the usual markings yellowish-white instead of white, and a dark vitta on 3 or 4 of the middle dorsal segments.

Pupa.—On April 12 I found three pupæ in the galls. Length .16 inch; abdomen orange, in one instance tinged with sanguineous, the rest of the body and the head bright sanguineous. The horn at the base of each antenna is obtusely conical, projecting in an angle of about 100° with a minute thorn at its apex, and the two horns divaricate from each other at an angle of 100°—110°. No post-antennal bristle. Thoracic bristle about ⅛ as long as the thorax is wide. A pupa examined April 15 was of a nearly uniform, palish, sanguineous color. The empty pupal integument (1 specimen) is uniformly whitish, save that the base of the antenna is a little obfuscated.

Imago. C. s. brassicoides n. sp. ♂ ♀.—(Recent) Brown-black, a little paler beneath. *Head* with the antennæ ♂ a little tapered towards the tip, about ¾ as long as the dried body, 22—24-jointed (2+20 to 2+22) and perhaps in a single antenna 20-jointed (2+18), the same individual often having one more joint in one antenna than in the other, the last joint even in the 24-jointed antenna tapered to a more or less elongate point at tip, so as to be undistinguishable from the last joint of a mutilated antenna; the flagellar joints globular, verticillate and pedicelled, with the pedicels ½ as long as the globular part, and the verticils fully as long as two of the complete joints from which they spring. Antennæ ♀ scarcely tapered, about ⅓ as long as the dried body, cylindrical at tip, moniliform towards the base, the joints difficult to count but apparently nearly as numerous as in ♂, short, sessile, and but slightly verticillate, the verticils as long as the one joint from which they spring. Occiput grayish in the living insect, black in the dried specimen. *Thorax* with erect, rather sparse, dusky hair; origin of the wings and a large spot beneath them orange or pale sanguineous in life, dull rufous when dried. Halteres (dried) brownish white, rarely fuscous, the club always more or less fuscous, its extreme tip generally showing a whitish reflection. *Abdomen* ♂ (recent) dorsally brown or dull luteous with cinereous hairs, ventrally pale brown or dull luteous with depressed whitish hairs. Abdomen ♀ (recent) with the dorsum sometimes entirely brown-black, sometimes brown-black with the hind edge of each segment when viewed from behind slightly sanguineous, sometimes dark sanguineous, sometimes sanguineous, sometimes with its anterior ½ sanguineous and its posterior ½ pale yellowish brown; sometimes again with brown hairs occupying ½ or ¾ of the anterior surface of each joint, and the lateral hairs cinereous and longer towards the tip of the joint, sometimes with cinereous hairs and the lateral hairs whitish, sometimes with the hairs, especially the lateral ones, twice as long and dense in one specimen as in another, the two both unrubbed and fresh and hatched out the same day; and finally sometimes on joints 3—6 with a subterminal, transverse, impressed, glabrous line, which in other specimens is obsolete or subobsolete. Venter ♀ sometimes dark sanguineous, sometimes sanguineous on the anterior ¾ and the rest pale yellowish brown, always with short, dense, appressed, white hairs concealing its color except where they are removed. Oviduct sometimes protruded so as to be ½ as long as the rest of the abdomen, sometimes entirely retracted so that the tip of the ♀ abdomen appears as truncate as in ♂. In the dried ♂ ♀ spe-

cimens the abdomen becomes of an obscure, blackish color. *Legs* brownish white or occasionally dull yellowish, in the living and sometimes in the dried specimen with a silvery reflection, sometimes with only the three or four terminal joints of the tarsi fuscous, sometimes in addition with the terminal ¾ of the femora superiorly fuscous, sometimes in addition with the superior surface of the entire leg, except the base of the femora, fuscous. *Wings* tinged with dusky from minute, short, appressed, dusky hairs, the cross-vein between the 1st and 2nd longitudinal veins always distinct, but placed close to the base of the wing. The 2nd longitudinal vein scarcely recurved at its extreme tip. Anterior branch of the 3rd longitudinal vein springing from the main vein at an angle of about 135°, and generally but not always traceable all the way to its origin; the entire branch recurved nearly so as to describe the one half of an ellipse about 3 times as long as wide and longitudinally bisected. Length (dried) ♂ .10—.15 inch, ♀ (including ovipositor) .16—.20 inch. Wing ♂ ♀ .18—.20 inch.

Six ♂, sixteen ♀, the first of which came out April 17 and the last May 26, others continuing to come out for several weeks afterwards. The ♀ ♀ are much more numerous, as usual in this genus, than the ♂ ♂.

No. 2. **Gall S. strobiloides** O. S.—On S. cordata. A monothalamous gall like a pine-cone, always on the tips of twigs when young, but often with small shoots of the same year's growth surrounding it, porrect, .50—.90 inch in its transverse diameter, and in stunted galls where the gall-maker has perished even as small as .20 inch in diameter, generally when viewed laterally with an ovate outline and the tip more or less truncate, occasionally subspherical. The leaves composing it are all sessile, closely appressed and imbricate, and all those on the outside are covered with a short, dense, glaucous-white pubescence on their entire exterior surface, and occasionally in a less degree on their interior surface, and are reddish-brown inside when mature, those on the inside of the gall becoming gradually smooth and reddish-brown on their exterior basal portion, and finally throughout. Towards the base of the gall the leaves are orbicular, the basal ones smaller; the next leaves are obovate and with their tips in a semicircle, and as they approach the tip of the gall oblanceolate, and in the inside linear-lanceolate and gradually smaller, slenderer and straighter, till they finally embrace the central cell containing the author of the gall. External leaves, except towards the tip of the gall, with a number of branching veins springing from their base, the midrib scarcely distinct from them by its superior size and throwing out similar branches, all of them obvious on the internal face of the leaf and obsolete on its external face. The tip of the twig from which the leaves spring, both in this and the 4 following species, is constructed as in *C. s. brassicoides.*

Described from 30 specimens. Very common and abundant in Rock Island County, Illinois, hundreds of them occurring on a single bush. None of the leaves composing this gall are ever serrate, as in the

willow on which it grows, but always entire. When young and immature, the galls are spherical and are enveloped in a dense mass of foliage, which gradually falls off towards the autumn, and by November the twigs on which they grow, if small, are already killed for an inch or two downwards. Occasionally at the extreme tip of the gall the leaves open out a little, as in *S. strobiliscus* n. sp., but without projecting from the tip as in that species. Easily distinguished from that gall by the portion of each leaf which lies "to the weather," towards the base of the gall, not terminating in a rectangular point, but describing a circular arc. The leaves are also more densely pubescent, especially the portion that lies "to the weather." Appears early in the summer and is full-sized by the middle of July, at which time that which is reddish brown in the dry gall is greenish white. The pubescence on the leaves retains its glaucous-white color to the last, except where they are badly weather-beaten. On the same bush throughout the summer may be seen the old, dry, last year's galls, and the young growing galls of the current year. I have already referred to the *Orchelimum* eggs often found under the scales of this gall. (*Proc. Ent. Soc. Phil.* III. p. 232.) In one gall examined this autumn I counted no fewer than 71 of these eggs. In September I detected a species of *Xiphidium*, which according to Mr. Uhler is undescribed, ovipositing in the pith at the tip of a broken stem of Golden-rod (Solidago). Probably *Locustariæ* Latr. (=Gryllidæ Leach) do not so generally oviposit in the earth as authors have hitherto led us to believe.

Larva.—Five specimens examined Nov. 15 and many subsequently did not differ from the larva of *S. brassicoides*, the breast-bone being similar and varying in the same manner. Length .08—.20 inch, breadth .04—.07 inch. Out of nearly 20 galls opened at this date all contained the cocoon, though many cocoons contained another cocoon in which lay a Proctotrupide imago about .10 inch long. The cocoon differs from that of *S. brassicoides* in being $2\frac{1}{2}$—3 times as long as the larva and truncate at tip, the tip end forming a kind of diaphragm not far from the tip of the lanceolate cell formed by the interior leaves. The diameter of the cocoon does not greatly exceed that of the larva, which is always found lying closely in its basal end, the rest of it being hollow and empty. Specimens of the larva examined Feb. 20 were of a pale orange-color, and others examined March 20 of a deep orange-color.

Others on April 23 were yellowish opaque with whitish mottlings and a honey-yellow vitta occupying $\frac{1}{3}$ of the dorsum on 4—6 of the middle dorsal joints. Another specimen was yellowish immaculate. On April 8 most of the galls still contained the insect in the larva state, and in a few the insect was still in that state April 30 and May 3.

PUPA.—Does not differ structurally from that of *S. brassicoides*. The first pupæ were found April 8, when the abdomen was tinged with sanguineous, and the fore part of the body, and especially the eyes, were strongly sanguineous. Another pupa occurred April 30 and others May 3. One that had been a week out of the cocoon was, on April 15, all bright pinkish-scarlet or sanguineous. The empty pupal integument (18 specimens) is whitish, scarcely tinged in front with fuscous. Length of the pupa (2 dried specimens) .15 inch.

IMAGO. *C. s.* STROBILOIDES, n. sp. ♂ ♀.—The imago differs from that of *C. s. brassicoides* only as follows:—1*st*. The ♂ antennæ are generally 21-jointed (2+19), but in one ♂ one antenna is 22-jointed (2+20), the two last unconnected by any pedicel. I noticed April 10 in the antenna of a recent ♂ (not the one with one 22-jointed antenna) that the last joint is small and cylindrical, equal in length to the penultimate but apparently connate with it. 2*nd*. The hair on the thorax is whitish, not blackish. 3*rd*. The dorsum of the abdomen ♀ is more nearly free from hair, and laterally the subterminal hair of each joint is longer, denser and whiter, and there is never, so far as I could observe in the recent specimens ♀, any subterminal, glabrous, impressed, transverse line on the middle joints. 4*th*. The origin of the anterior branch of the 3rd longitudinal wing-vein is always obsolete for a short space, as it sometimes is also in *C. s. siliqua* n. sp.? and occasionally in *C. s. brassicoides*. The dimensions are about the same as in *C. s. brassicoides*. Five ♂, twenty-eight ♀. The first imago appeared April 5 and the last May 10, the ♀ ♀, as usual, much more numerous than the ♂ ♂. On April 6 a ♀ laid very numerous eggs, which were cylindrical, 3 times as long as wide, .03 inch long, blunt-pointed at each end, and of a blood-red color, in the bottle in which I had confined it.

No. 3. GALL S. STROBILISCUS, n. sp.—On S. rostrata, a high northern willow not found near Rock Island. I only know this species from a single dried and mature specimen received from Mr. Bebb, and gathered in Winnebago Co., on the extreme northern border of Illinois.

It has a diameter of .70 inch and differs from *S. strobiloides* O. S. 1*st*. In the tips of all the leaves on the outside of the gall, and not merely those towards the tip of the gall, being angulated not rounded. 2*nd*. In their external surface not being so strongly pubescent, especially the portion lying "to the weather." 3*rd*. In the leaves at the tip being almost linear or parallel-sided instead of oblanceolate, and proportionally about ½ longer so as to project in a kind of beak from the tip of the gall. 4*th*. In the tip of the gall being more open than is usual in *S. strobiloides*. 5*th*. In the veins even on the inside of the leaves being subobsolete. The cocoon, as far as can be judged from what remains of it, was similar to that of *S. strobiloides*, but unfortunately it contained, not the larva or pupa of the *Cecidomyia*, but a parasitic *Callimome*, which infests several of these Gall-gnats, in the imago state. Hence, and from the fact of there being catkins in flower on the twig on which it grew, we may know that the specimen was about 10 or 11 months old when gathered. As usual in mature *S. strobiloides*, the twig on which it grew had been killed immediately below it for the space of ½ an inch or so. Since it might possibly have been the case that it was this species, and not my *S. strobiloides*, which was named *strobiloides* by Baron Osten Sacken, as he merely describes his gall as being "in the shape of the cone of a pine and an inch or more long," I communicated to him the distinctive characters between the two species, and he has been kind enough to inform me that my *S. strobiloides* is identical with his. The specimens which he originally used were obtained in Northern Illinois, and he tells me that he afterwards gathered a single one in Massachusetts, so that we know of this one gall, at all events, that has a wide geographical range.

LARVA, PUPA and IMAGO unknown.

No. 4. **Gall S. gnaphalioides**, n. sp.—On S. humilis. A monothalamous, small, solitary, oval or sometimes subspherical gall, .23—.55 inch long and .14—.60 inch in diameter, almost always growing at the tip of a twig and without any side-shoots around it, very rarely from the side of a twig from a small side-shoot no longer than itself, sometimes porrect but oftener with the last inch or so of the twig on which it grows curved downwards, or angularly bent downwards, or coiled 2 or 3 times round like the tendril of a vine. The leaves composing it are imbricate, sometimes more or less loosely appressed, (when it resembles somewhat the little lemon-yellow garden-flowers known as "everlastings" or "immortelles" or the indigenous Gnaphalium polycephalum,) but more usually opened out towards their tips, and always with their extreme tips

more or less pinched together so as to form a kind of beak and frequently reflexed. These leaves are all entire, sessile, pale green in the summer and in the autumn of a pale reddish brown or pale yellowish brown color with fine, appressed, whitish pubescence on their external surface, and they have a few indistinct longitudinal veins but no normal midrib and side veins as in *S. rhodoides*. At the base of the gall they are small and orbicular, then larger and orbicular, then oval, then towards the tip of the gall elongate-oval and elongate-obovate, the tip of the leaf in each case taper-pointed in an angle of about 80° so as to form the beak before spoken of. In the inside they become linear-lanceolate and envelop the central cell as in the preceding species.

Described from 72 specimens. Attains its full size by the end of July, and is quite common near Rock Island, Illinois. In two or three cases where the potato-like gall *S. batatas* n. sp. grew at the tip of a twig, I have noticed the gall *S. gnaphalioides* growing sessile from near the tip of the other gall, evidently from one of the buds included in it. In November I have observed that many of these galls have the larva picked out of them, evidently by birds, and in February full ¾ of them are thus emptied, the leaves of the gall being pecked off on one side. This does not occur with the allied galls *S. brassicoides*, *S. strobiloides*, and *S. rhodoides*, probably because the larva is there concealed and protected by a much thicker wall of leaves; but I have repeatedly in the winter noticed the same thing of the large, spongy gall of the Dipterous *Trypeta solidaginis* Fitch. Easily distinguished from its five allies by its much smaller size. From *S. brassicoides* it is also distinguished at once by its always being solitary; from *S. strobiloides* by the tips of the leaves that lie "to the weather" being not rounded but angulated and beaked; from *S. strobiliscus* by the tips of the leaves being generally opened out and recurved, and always beaked; and from *S. rhodoides* and *S. coryloides* by all the leaves being sessile, instead of the terminal leaves, and in the latter case almost all the leaves, having peduncles.

LARVA.—On July 30 the larva was not yet discoverable in the gall. August 27 it was .06—.07 inch long, yellowish or orange-color, with dominant, bowel-like, white markings, and the breast-bone indistinct. Several larvæ examined November 11 and 18 were undistinguishable from those of *S. brassicoides*, *S. strobiloides* and *S. rhodoides*, and had the same breast-bone with the same variations. Length .10—.12 inch. In over a dozen galls opened at these dates the larva had made its cocoon, which was 1½—2 times as long as the larva itself and of the usual

white, filmy texture, and had the same diaphragm at tip as in *S. strobiloides*. On March 6 the galls still contained the insect in the larva state.

Pupa.—April 23 and May 12 I found four living pupæ in these galls. They differed structurally in no respect from those of the preceding species, and were nearly as long as the cocoon and not far short of the length of the gall. The abdomen was dark blood-red, generally tinged and marked with fuscous, the other part of the body, including the wing-cases and legs, blackish, except the thoracic bristles, which were in one specimen noticed to be whitish. One of these four developed into the imago an hour after the description was taken. Length (4 dried specimens) .12—.13 inch. The pupal integument (3 specimens) is whitish, immaculate. On opening 20—30 galls May 13, from which I had attempted to breed the imago, I found dead pupæ in all of them

Imago. C. s. gnaphalioides, n. sp. ♀.—Differs from *S. brassicoides* ♀ only in the size being slightly smaller and the hair of the thorax whitish not blackish, and in the lateral sub-terminal hairs on the joints of the abdomen being perhaps a little longer than is usual in that species. The halteres are almost entirely pale; and the legs are as pale as in the palest *C. s. brassicoides*, and perhaps slightly more whitish. From *S. strobiloides* ♀ it differs in the size being slightly smaller and in the origin of the anterior branch of the 3rd longitudinal vein being pretty distinct; from *S. rhodoides* ♀ only in the size being slightly smaller; and from *S. siliqua* ♀ in the legs and the hair of the thorax being rather whiter, and also, as in the preceding three, in the size being slightly smaller. Length ♀ (including oviduct) .12—.15 inch; wing ♀ .12—.16 inch. Three ♀; ♂ unknown. Appeared April 23—May 6. One of the above ♀ ♀ was immature, and when recent had the abdomen sanguineous, the medial ⅓ of the dorsum of each joint covered with pale brown hair, and no lateral subterminal white hairs; the venter was covered with short, appressed, white hair. Another ♀, which I had kept alive and exposed to the light for 2 days, had when recent the medial ⅔ of the dorsal joints of the abdomen deep brown, the other part bright sanguineous, and the venter sanguineous with short, appressed, white hairs. In this specimen, even when dried, the lateral white hairs of the dorsal joints of the abdomen are pretty obvious.

No. 5. **Gall S. rhodoides**, n. sp.—On S. humilis. A monothalamous gall like an elongated rose, always growing singly on the tip of a twig, porrect, its general outline elongate-spherical, occasionally spherical and rarely short-spherical, .90—1.80 inch long and .70—1.90 inch in diameter, never with any twigs, however small, growing round it from the same stem. The leaves composing it are slightly pubescent, entire, with the midrib and branching side-veins very conspicuous, and are almost always opened out and with their tips recurved and occasionally at the extreme tip a little pinched together, but in a few cases they are loosely appressed except at the tip of the gall. The basal ones are small, the following ones larger, all sessile and heart-shaped with the basal lobes of the heart squarely truncate and the tip almost always taper-pointed in an angle of 70°—80°: towards the tip the leaves become smaller and gradually more and more peduncled, till at the extreme tip the peduncle is generally twice as long as the leaf itself. Inside the gall the leaves suddenly become linear-lanceolate and gradually straighter as they approach the centre, till they finally embrace the lanceolate central cell precisely as in *S. strobiloides*. Sometimes the peduncled leaves at the tip protrude from the gall as the stamens and pistils of some flowers protrude from the corolla.

Described from 15 galls freshly gathered in November, and 50—70 gathered in July. Very common in Rock Island County, Illinois. This gall arrives at its full size by the middle of July, when the outside leaves are externally palish green, often changing towards the tip of the gall to pale yellowish green slightly tinged with rosy and externally more or less glaucous. In the autumn the leaves become pale greenish brown with a slight whitish pubescence externally, and, after hanging on the twig over a year, almost black.

LARVA.—By July 30 the larva is already .07 inch long, subhyaline, with opaque, curdy, white markings, and a long internal yellow stripe representing probably the intestinal canal; breast-bone indistinct. November 16, out of about a dozen galls opened, all but one larva had formed their cocoon, which exactly resembles that of *C. s. strobiloides*. The breast-bone in all was quite distinct and resembled exactly that of *C. s. brassicoides*, varying in the same manner, and in all other respects the two larvæ were undistinguishable. Length .10—.12 inch. On February 25 the larva (many specimens) was .15 inch long, pale orange, the orange color mostly concealed, except the sutures and sometimes the 3 anterior joints and a dorsal line, by whitish, bowel-like markings. A larva examined April 23 was .19 inch long, .07 inch wide, yellowish opaque, with whitish bowel-like markings and a broad dorsal fuscous vitta. Breast-bone as in *C. s. strobiloides*.

Pupa.—March 16 I found a gall with the insect in pupa. A pupa examined April 15 was yellowish a little mottled with sanguineous, but in all other respects exactly resembled that of *C. s. strobiloides* when placed side by side. Another examined April 21 had the thoracic bristle rather robust at base and tapering towards the tip, but in the dried specimens this part is undistinguishable from the same part in *C. s. strobiloides*. April 23 of 3 pupæ examined one was pale sanguineous, with the wing-cases and legs pale yellowish and the abdomen mottled with yellowish between the sutures, and two were blackish, including the wing-cases and legs, with the abdomen sanguineous or dull lake-red broadly vittate dorsally with fuscous. An hour afterwards the two last developed into the imago state. Length (3 dried specimens) .15—.17 inch. The empty pupal integument (11 specimens) is nearly pure white throughout.

Imago. C. s. rhodoides n. sp.—The imago ♂ ♀ is undistinguishable from that of *C. s. brassicoides*, except as follows:—1*st*. The antennæ ♂ are 23—25-jointed (2+21 to 2+23), with the last joint elongate and sometimes even in the 25-jointed antenna appearing to be composed of two connate joints. In a single ♂, which has only one antenna, the antenna is 21-jointed (2+19,) the last joint very small and without any pedicel, and I counted the joints as "20 or 21" in the same specimen when recent. Occasionally in the same specimen there is one more joint in one antenna than in the other. 2*nd*. As in *C. s. strobiloides*, *C. s. gnaphalioides* and *C. s. siliqua*, the hair of the thorax is whitish instead of blackish, and it is more conspicuously whitish than in the last-named species. 3*rd*. As in these species, the subterminal, lateral hairs of the dorsal joints of the abdomen are longer, denser and whiter than they usually are in *S. c. brassicoides*, and the subterminal, transverse, glabrous line seen in some *C. s. brassicoides* is not perceivable. 4*th*. The legs are rather whiter than is usual in *C. s. brassicoides*. On April 21 a ♂ emerged from the pupa under my eyes. As it came out, the abdomen had the sutures widely sanguineous and the tip sanguineous, the dorsal space between the sutures covered with appressed brown hairs which occupied the medial ½ of each joint. The venter was dull yellowish. Three hours afterwards the dorsum of the abdomen, including the sutures, was entirely fuscous, and also the venter except the tip and forceps which were

yellowish. A ♂ examined April 28 had the dorsum of the abdomen entirely fuscous, but on removing some of the dorsal hairs the sutures were narrowly blood-red when viewed from behind. The venter was dark blood-red on removing some of the white pubescence which concealed the color. A mature ♀ on April 21 had the dorsum of the abdomen fuscous, except the sutures which were slightly brick-red. Another ♀ less mature had the whole dorsum of the abdomen a dirty red and the venter brick-red. April 22 a ♀ had the abdomen dorsally fuscous with a few appressed brown hairs with no reddish sutures, the venter dull rufous and the oviduct rufous. Another ♀ April 25 had the dorsum of the abdomen fuscous, with the sutures narrowly sanguineous, but only when viewed from behind. The venter, on removing some of the short whitish pubescence, was dark blood-red. Dimensions about the same as in *C. s. brassicoides*. Eight ♂, seven ♀. The first imago appeared April 12 and the last April 28.

No. 6. **Gall S. coryloides** n. sp.—On S. discolor? A very large and loosely expanded, monothalamous gall, resembling at a distance a bunch of hazel-nuts in their natural husks, growing singly at the tip of a twig without any shoots surrounding it, porrect, its general outline spherical, sometimes elongate-spherical or short-spherical, 1.76—2.35 inch long and 1.95—4.10 inch in diameter. The leaves composing it are on the outside large in proportion to the size of the gall, so that some of the middle ones are occasionally two inches across, free from pubescence except sometimes on their external base, entire, with the normal midrib and branching side-veins distinct, and are all of them very much opened out and recurved, the basal ones the most so, so that the latter often touch with their tips the twig on which the gall grows. The basal leaves are orbicular-ovate or ovate, only slightly smaller than the middle ones; the middle ones are ovate, and both basal and middle ones have their tips tapering regularly in an angle of about 80°—90°, not taper-pointed in an angle of 70°—80° as is generally the case in *S. rhodoides;* and their base describes an angle of about 90°, instead of being squarely and widely truncate, as in *S. rhodoides*, and even on the extreme base of the gall generally has a short peduncle nearly ⅛ as long as the leaf itself, which in each successive leaf gradually becomes longer as the tip of the gall is approached, when it is about equal in length to the leaf, which has now become oblanceolate. On the inside, the leaves suddenly become straight, porrect, and very much smaller, and are elongate-linear with their tips tapered to a very acute point, closely appressed, and gradually smaller, till they finally embrace the lanceolate central cell. In the autumn the leaves of this gall are dark reddish-brown, externally with a slight whitish bloom; at other seasons it is unknown to me.

Described from 4 specimens. Very near *S. rhodoides*, which occurs on a totally different willow, but sufficiently distinguished by the cha-

racters specified in the description, as well as by its average size being just double. One of the above 4 galls had the heart eaten out by some lepidopterous larva; and adhering to the leaves of another was the pupal integument of a Lepidopteron, much larger than any of those commonly bred by me from the allied galls. All of them, as is very generally the case in this group of galls, had many of their leaves eaten into by Lepidoptera, and contained much Lepidopterous "frass" or excrement.

I know but three Willow-bushes near Rock Island which can be referred to S. discolor. One of them, a ♀, of which I forwarded to Mr. Bebb the inflorescence, was pronounced by him to be certainly S. discolor; it was from this one that I obtained the galls, which for the present I refer to *S. batatas* and *S. siliqua*. Of the second, also a ♀, I forwarded nothing but the fruit, and Mr. Bebb referred it doubtingly to S. discolor, but thought it might possibly be S. eriocephala. I have carefully compared foliage, twig and bud in these two, and have little doubt they are identical. At all events their very robust, vigorous twigs, tinged with purple and covered with whitish pulverulescence, so as strongly to recal those of many varieties of apple-tree, and the large buds which have commenced opening out even as early as the last of November, effectually distinguish both, even in the winter time, from the 4 other species of Willow found near Rock Island. The third bush was not discovered by me till the last of November, and agrees so perfectly in all the above characters with the one which is undoubtedly S. discolor, as well as in the foliage, some of which still adhered to its twigs, that I have little hesitation in referring it to the same species. I observed however on its main limbs large blotches or wide bands of whitish-gray, which could not be seen on either of the other bushes. In any case the inflorescence next spring will definitively decide the question of its specific identity with S. discolor. It was on this last that I found the galls *C. coryloides;* the second bush bore no galls at all.

It thus appears that of the 5 willows growing near Rock Island, four have galls all constructed on the same fundamental principle out of deformed buds, and one of them—S. humilis—has two such galls. It is a remarkable and suggestive fact, that the remaining willow has no such galls nor anything approaching to them. In numberless localities

where this species—S. nigra—grows promiscuously intermixed with S. longifolia or with S. cordata. I have in vain hunted time and again for them, both in the summer and in the winter, when they could be seen with the greatest ease, even if they were only half the size of *S. gnaphalioides*. But for this fact, and the further fact of S. humilis bearing two distinct galls of this peculiar type, we might, from the great similarity of their insects, both in the larva, pupa and imago states, infer that they were all of them merely what I have called Phytophagic Varieties, instead of being specifically distinct, and each confining themselves to their appropriate species of willow.

LARVA.—Undistinguishable from that of *C. s. brassicoides*; breast-bone identical and with the same variations. Length .12—.15 inch, width .06—.07 inch. Three specimens. The cocoon is of the usual thin, delicate texture, whitish and about as long again as the larva.

PUPA and IMAGO unknown.

No. 7. **Gall S. cornu.**—On S. humilis. A lateral bud deformed into the shape of a monothalamous, very elongate, slender, cylindrical, tapering, hollow, rigid horn, very slightly pubescent, of a very dark reddish brown color when mature, and with about 12 or 14 longitudinal, pretty regular striæ like a coleopterous elytrum. This gall is .30—.77 inch long, .07—.10 inch in diameter at base and .05—.07 inch close to the tip, where for the length of about .10 inch it is flattened and moderately pubescent, and at the extreme tip, which is rounded, opens by a terminal slit. Sometimes it is solitary, sometimes 2 or 3 of them, or even as many as 10, grow at irregular intervals on a small twig 4 inches long, with a few of the intervening buds in their normal condition. Generally it is perfectly straight, diverging upwards from the twig at an angle of 15°—35°, but occasionally it is a little bent in the middle, and occasionally it curves backwards in a regular curve, so that in one instance the tip nearly touches the base. When cut into, the walls of the hollow are seen to be no thicker than stout paper, but very stiff and hard, and on the terminal ½ the internal surface is pretty smooth with indistinct longitudinal rugæ, except the terminal .05 inch, which is armed with very long, whitish pubescence directed obliquely forwards. In the basal ½ of the horn lies the cocoon, which is closely agglutinated to the walls of the cell except at its tip, where it forms a filmy, whitish diaphragm as in *S. siliqua* n. sp.? The cell formed by the hollow of the deformed bud is prolonged into the woody origin of the bud for .10—.15 inch, but the twig itself is not swelled or deformed, as it is in the allied polythalamous gall *S. triticoides* n. sp., further than by a slight and scarcely noticeable intumescence at the origin of the bud.

Described from 8 living specimens on four different twigs and 10 old dead and dry specimens all on one twig, the whole gathered in Novem-

ber. Out of the 18, 6 or 7 had been bored laterally by some minute parasite, and from at least two of the recent ones parasites had perhaps escaped at the terminal slit, for they contained neither larva nor cocoon, and were unbored, although one of the recent ones was bored. Rare near Rock Island, and difficult to discover from its simulating a short, lateral twig. When these galls occur in great numbers on a twig, the intervening buds perish, but when there are only one or two of them, they do not. When the twig is .08 inch or less in diameter, the part of it which lies beyond the galls shrivels up and perishes, even if there be only one of them, but when the diameter is .13 or over and there is but a single gall, it survives, at all events till the next season.

LARVA.—Sanguineous with yellow bowel-like markings, about .08 inch long and .04 inch wide; breast-bone as in *C. s. brassicoides*, but as in some varieties of that species, with the posterior arm of the Y only about ⅔ as long as each anterior arm, and terminating behind in a square truncation. The cocoon is described under the head of the gall. One specimen, found in November.

PUPA and IMAGO unknown.

No. 8. **Gall s. siliqua**, n. sp.?=*Salicis?* Fitch=*rigidæ?* Fitch, O. S.—On S. humilis (and also on S. cordata? and S. discolor?) A monothalamous, solitary, oval or subspherical, woody gall, .55—1.00 inch long and .20—.34 inch in diameter, growing at the tip of a twig, frequently with several twigs apparently of the same year's growth surrounding it, tapered at tip to a short, blunt, tubiliform beak, which is evidently a deformation of the terminal bud, and hollow inside. The outside surface of the gall, which is the natural color and texture of the bark of the twig, always contains, besides the terminal beak-like bud, 2—5 buds, which are still alive in November in the recent gall but afterwards perish along with the gall itself, as does also, unless the twig on which the gall grows be large, a portion of that twig. Sometimes one of these external buds sprouts out into a twig, growing from the outer surface of the gall, and in a single specimen there are four such twigs. The walls of the internal cell or hollow, including the bark, are .06—.11 inch thick, and lined when mature inside with the cocoon of the gall-maker, which is detached and of the usual delicate texture towards the tip of the hollow, so as to form a kind of diaphragm to exclude any air that might enter through the terminal beak, but is agglutinated strongly to them everywhere else, though it may be detached piece-meal, generally with a thin layer of the greenish woody matter adhering to it. The internal surface of the terminal beak is smooth, continuous with that of the main cell or hollow, and not strongly pubescent at tip as in *S. cornu*; on its external surface there is the natural suture at its base. In one specimen, where a large, abnormal, woody wart had been formed about the middle of the hollow, the larva, instead

of including the wart in his cocoon, had had the remarkable foresight to construct his cocoon entirely above the wart, and was thus compelled to make another diaphragm just above the wart, besides the usual one near the beak, and to lie in a much smaller compass than usual between the two.

Described from 10 living specimens and 27 old and dead ones, all from S. humilis. Rather rare near Rock Island. Varieties of *S. batatas* n. sp. occur, which externally can scarcely be distinguished from *S. siliqua;* but on cutting into them they are seen to be not hollow, but filled with a spongy substance containing several of the cells which are inhabited by the *Cecidomyia* of that polythalamous Gall; and moreover, the terminal bud is not beak-like and tubiliform.

Specimens found on S. cordata in November differ as follows:—1*st*. The average dimensions are about $\frac{1}{6}$ smaller, the length in 4 living specimens and 41 dry and dead ones being .45—.85 inch and the breadth .17—.28 inch. 2*nd*. Out of three of the living galls where the *Cecidomyia* was present, there was in two a double diaphragm both at top and bottom of the hollow, instead of the single diaphragm at the top only; but in the other one the diaphragm was single and normal. 3*rd*. The number of buds on the external surface of the 45 galls is 1—3 instead of 2—5. 4*th*. The terminal beak in $\frac{1}{3}$ of the above 45 specimens is conspicuously recurved, whereas it is never recurved in those that grow on S. humilis, though it is sometimes a little oblique and in a single specimen is at right angles to the axis of the gall. A gall found August 1 had the beak so much recurved as to touch the side of it, like the tongue-case of the pupa of Sphinx 5-maculata Haw.—From my having in two successive seasons found the old dead and dry galls on both the above two willows at least 8 or 10 times as numerous as the green ones, and from the very weather-worn appearance of many of them, and the fact that a few of them were overgrown and almost obliterated by the twigs that surrounded their base, I infer that they hang on the twig for several years.

A single living gall gathered on S. discolor in November differed from the living ones found on S. humilis as follows:—1*st*. The woody matter composing the outer shell is much thinner than in any one of 14 green specimens off S. humilis and 3 green specimens off S. cordata that I have cut into, being to a much greater extent medially interrupted by a layer of brown spongy matter, so that the gall was rather crushed by

the knife than cut by it. *2nd.* Instead of the external surface being plump and of the natural texture of the bark of the twig, it was strongly rugose, when recently gathered, and had much the color and texture of a completely withered blue plum. This does not occur in green specimens found at the same time of the year on the other two Willows, though it is often seen in the old dry ones.—Length 1.00 inch, diameter .30 inch, external buds 3. One specimen.

Larva.—The larva found in the S. cordata gall with recurved beak August 1 was .06 inch long, bright opaque orange with a ventral and dorsal semitranslucent, polished, broad, orange vitta, and the breast-bone indistinct. A very large specimen from S. humilis examined November 15 was bright sanguineous with yellowish bowel-like markings and the breast-bone as in all the preceding species, except that, as in six others examined November 21, viz: 3 from S. humilis and 3 from S. cordata, the former .13—.17 inch and the latter .17—.19 inch long, it was stouter and blacker, and the two anterior horns of the Y were only $\frac{2}{3}$ as long as the posterior part. This seems to be the prevalent variety in this species, none having hitherto occurred that varied *vice versa*, as in all the preceding species, though one or two have occurred with the 3 arms of the Y subequal. Length .23 inch, breadth .07 inch. I have occasionally found specimens both of *C. s. brassicoides* and *C. s. strobiloides* which were similarly elongated not temporarily but permanently; but in this species they are always so. Another specimen from S. humilis examined February 26, was orange-colored, and another from the same willow on March 21, was pale sanguineous orange freckled with bright sanguineous and .18 inch long. By November almost every larva had made its cocoon, which is described under the head of the Gall. The larva obtained in November from the gall on S. discolor was undistinguishable from six specimens found at the same date in galls from the other two willows, except that the breast-bone was larger, blacker and full $\frac{1}{4}$ more robust, being nearly as broad as long, instead of $\frac{1}{2}$ as broad as long. I have, however, since noticed that specimens of *C. s. strobiloides*, &c., occasionally occur which vary in the same manner from the normal type, i. e. in having a much more robust breast-bone.

Pupa. The first pupa (from S. humilis) was found April 12. It did not differ materially from any of the preceding, but the pupal integument (7 specimens) differs most remarkably from those of all my other *Cecidomyia* in the whole of it, except the abdomen, being strongly tinged with fuscous. It would be interesting to know whether Dr. Fitch's species has the same peculiarity. The pupa makes its exit through the terminal beak of the gall, forcing its body halfway out of it and there transforming, or sometimes falling entirely out. Length (from the pupal integument) .17—.19 inch. The pupa from the galls on S. cordata and S. discolor I do not know.

IMAGO. C. S. SILIQUA, n. sp.? ♀ —Scarcely distinguishable either in the recent or dried specimen from ♀ *S. rhodoides* though the hair of the thorax is not of so pale a white, as it is in *C. s. strobiloides*. *C. s. gnaphalioides*, and *C. s. rhodoides*. In all the dried specimens, indeed, the legs are tinged with luteous, but so are they in several *C. s. brassicoides*, *C. s. strobiloides*, and *C. s. rhodoides*. The dimensions are also about the same. From *C. s. brassicoides* it differs in the hair of the thorax being whitish, and from *C. s. strobiloides* in the origin of the anterior branch of the 3rd longitudinal vein being pretty distinct. From *C. s. gnaphalioides* it can scarcely be distinguished but by its somewhat larger size, though it is possible that the ♂ ♂ may differ in the average number of their antennal joints. Seven ♀ , all bred from the gall of S. humilis; ♂ unknown. From the slight but apparently constant difference, in the galls found on S. humilis and S. cordata, I incline to believe that we have here what I have called a Phytophagic Species in an incipient state of formation. *C. s. brassicoides*. *C. s. strobiloides*, *C. s. gnaphalioides*, *C. s. rhodoides* and *C. s. coryloides* I consider as well and long established Phytophagic Species, and that the way it came about that there are two of them on one willow—S. humilis—namely, the 3rd and 4th species, was, that they migrated ages ago on to that willow from two other distinct species of willow, and therefore, when they finally settled down on S. humilis, their gall-producing secretions had different chemical properties, as we find to be the case in *Cynips q. spongifica* O. S. which is confined to the Black Oak, and *C. q. inanis* O. S. which is confined to the Red Oak, the two imagos of these species being, as in so many *Cecidomyia*, utterly undistinguishable ♂ ♀.

As already stated, (p. 545) there is a gall (Salicis Fitch.=rigidæ O. S.) described by Dr. Fitch as growing upon S. rigida and S. lucida, which seems identical with the above. Through the politeness of A. Agassiz, Esq., I have been favored with a copy of Dr. Fitch's Article on the subject, and also of his drawings, from the *Quarterly Journal of Agriculture and Science*, Vol. I. p. 263. From these it results that the two galls, so far as can be seen, are scarcely distinguishable; and the same may be said of the larva and pupa as described by Dr. Fitch. As regards the imago, he has manifestly—as appears both from the description and the figures of the antennæ, the joints of his ♂ antennæ being

figured as sessile and those of his ♀ antennæ as pedicelled—described the ♂ as ♀ and the ♀ as ♂, and mistaken the ♂ anal forceps for an oviduct; and since the ♂ [♀] antennæ are said to be 20-jointed, his statement that the ♀ [♂] antennæ are 16-jointed must surely be either a clerical or typographical error, for in *Cecidomyia* the ♂ always has at least as many antennal joints as the ♀. (*Dipt. N. A.* p. 175.) It is possible, on the assumption that there is no clerical or typographical error here, that he might have bred from these galls the ♂ of some inquilinous species unknown to me, which, like my inquilinous *Cec. albovittata*, had a much smaller number of antennal joints than the author of the gall which it inhabited, and so mistaken it for the other sex of the ♀ that really makes the gall. As will be shown below, the gall-making *C. s. batatas*, which has ♂ antennæ 18—19 jointed, sometimes on *S. humilis* oviposits on the same twig as *C. s. siliqua*, so that the two galls run together. But no one could mistake the ♂ of that species for the ♂ of *C. s. siliqua*, from its very different size and coloration. After making the necessary allowances, however, I do not see that this imago can be satisfactorily separated from my species. Below will be found, in a condensed form, the leading points in Dr. Fitch's descriptions, omitting such details as are of a generic, rather than of a specific character.

"**Gall Salicis** Fitch (=*rigidæ* O. S.) Plate II. fig. 7.—Formed at the tips of the twigs of several willows growing to the size of shrubs or small trees, of an oval or long ovate form, from ¾ to 1½ inch long, ¾ inch in diameter at the broadest part, externally red, yellow or greenish brown, being the same color as that of the particular twig upon which it grows. Some of the natural buds of the shrub often occur upon the surface of the gall, as bright and vigorous as they are on the unaffected branches. Frequently one or two twigs grow from its sides, appearing so well nourished and thrifty through the winter season, that we could scarcely deem they were destined to perish the ensuing summer, did not an inspection of the old galls show their similar shoots almost invariably rotten and decaying. Three-eighths of the upper end of the gall is dry, brown and brittle, curving to a point like the kernel of Ergot or spurred rye and protruding from the gall, a well-marked line of separation occurring at the junction of the dead with the lower, living portion. Within, its substance is of a greenish white color and of a soft woody texture. A cylindrical canal, .10 inch in diameter, within which the larva lies, runs from the base of the gall to the apex of the brittle horn at the summit. The extreme tip of the horn is so brittle that it is easily broken by the slightest touch and is rarely found entire.

"**Larva.** Plate II. fig. 3.—A small worm of a bright orange color, with the ante-

rior extremity red, .20 inch long and .08 inch in diameter, of a cylindrical form, slightly tapering and obtusely rounded at both ends, but more so at the posterior than at the anterior extremity. A slightly projecting point perceptible at the apex of the anterior end, and two similar projections at the opposite extremity. The larva is composed of nine segments, each well marked by a contraction intervening at the joints. The anterior or head segment is the largest, and has near the tip on the under side two small black lines, slightly diverging from each other as they proceed forwards. A dorsal row of deep pink spots of a square or trapezoid form on each segment, reaching from its anterior edge about $\frac{1}{3}$ of the distance across the segment; a very slender pink-red line reaching backwards from each stigma across the segment; and a similar line from each of the dorsal spots. Other lines of the same color are often visible upon the surface, branching from and anastomosing with these like blood-vessels.

"**Pupa.** Plate II. fig. 2.—The dimensions do not differ perceptibly from those of the larva. The abdominal segments are of the same orange color as the larva; but the future head, thorax and wings are sanguineous-red and lustrous.

"**Imago. Cec. Salicis** Fitch, (=*rigidæ* O. S.) Plate II. fig. 1.—Black, hirsute: wings lurid; venter with white pubescence: legs lurid. Length .18 inch. Expanse wings .35 inch.

"*Head* with a ruffle of fine, velvet-like hairs surrounding its base. Antennæ shorter than the thorax, moniliform, slightly and gradually diminished in diameter towards their tips; joints 20 in number ♂ [♀], each with a few very minute hairs directed forwards, 16 [26?] in number ♀ [♂], each verticillated with longer and coarser hairs. *Thorax* with two impressed, longitudinal lines on the back, slightly converging posteriorly, and densely set with minute hairs: the intermediate space glabrous: sides with longer hairs, most conspicuous and thickly set forward of the wings. *Abdomen* with the posterior edge of each segment marked above by a lighter tinge, beneath chestnut brown, thickly covered with short, white hairs of a silky lustre. Abdomen ♀ [♂] terminated by a slightly exserted, two-jointed ovipositor [♂ forceps] of a cinnamon yellow color. *Legs* glabrous, long and slender, the hinder ones extending .27 inch, of which the tarsi measure .13 inch, blackish above, beneath lurid brown: tarsi black, the first joint very short, the third [second] longest and most slender, the fourth and fifth broadest. *Wings* smoky brown, translucent, the nervures except the anal [3rd longitudinal] rectilinear: the postcostal [2nd longitudinal] longest, running direct to the tip of the wings: the medial [anterior branch of 3rd longitudinal] scarcely confluent with the inner margin at $\frac{3}{4}$ the distance from the base to the tip, towards its base becoming a mere plait-like trace upon the wing, and at the first glance seeming to be a branch of the anal nervure [3rd longitudinal.]"

On comparing the average dimensions of Dr. Fitch's gall with those of the gall found by myself on S. humilis, the former averages 1.12 inch long and the latter only .77 inch long, and the diameter of the former is given as .37 inch while the average diameter of the latter is only .27

inch. The difference becomes still greater if we compare the average dimensions of the gall found by myself on S. cordata. Again, Dr. Fitch gives the length of the terminal bud or beak, which, as he correctly observes, is divided by "a well-marked line of separation" from the rest of the gall, as $\frac{3}{8}$ of the length of the entire gall. In three freshly gathered specimens from S. humilis, where the terminal bud is perfect and uninjured, I find that it only averages .28 of the length of the entire gall instead of .37 ($=\frac{3}{8}$), and I am satisfied that these three were fair average specimens, from comparing them with those used in my descriptions. On measuring Dr. Fitch's figure, I find that the bud is .35 of the length of the entire gall, thus proving that the comparative length of the bud, .37 or $\frac{3}{8}$, given in the text, cannot be typographically erroneous.

From the description of the larva as 9-jointed, it would appear that Dr. Fitch considered the last bi-tuberculated or anal segment as a mere anal process, and the three thoracic segments, (which in *Cecidomyia* are never so clearly separated from each other as the abdominal segments,) as forming, together with the minute true head which is very generally retracted, and which is no doubt the "slightly projecting point" in the text, an enormous head or "head segment," bearing "near the tip on the under side two small black lines," which are manifestly the breast-bone. By thus deducting 4, viz: the anal and the three thoracic segments, from the real number of segments, viz: 13, including the head, we obtain the required number, 9.

In the description of the imago there is nothing said as to the ♂ (♀) antennæ being pedicelled, but the figure, though rather rough, represents them with pedicels about $\frac{1}{2}$ as long as the joints, and the verticels about as long as two complete joints, just as in the ♂ of all the allied species. So near as I can guess at the number of joints in ♀ antennæ of my species, I should say they are 21 (2+19); but, as already stated, I find it hard to count the joints of the ♀ antennæ in the Willow *Cecidomyia* with precision, from the terminal ones being so closely united. The ♂ of my species is unknown to me, so that I cannot compare it with the ♂ of the other form. Strictly speaking, as Dr. Fitch gives "black" as the ground-color, and says nothing of the color of the hairs of the thorax, they ought to be black, whereas in my species they are grayish white. Probably, however, this was a mere oversight, or a

clerical or typographical error, like the statement that the *third* joint of the tarsi is "the longest and most slender," whereas in all true *Cecidomyina* it is the *second* joint that is by far the longest of the five. The dimensions, including those of the legs, agree exactly. Harris incorrectly gives the length as "a little over .20 inch," and the alar expanse as "rather more than .30 inch," (*Inj. Ins.* p. 567,) which makes the expanse proportionally too little by nearly .08 inch, taking Dr. Fitch's measurements as the standard of comparison.

No. 9. **Gall S. triticoides.** n. sp.—On S. cordata. A polythalamous, woody gall .70—1.23 inch long and .30—.37 inch in diameter, bearing a remote resemblance to a head of wheat with the kernels elongated, naked, pointed and very protuberant, its general outline oval or elongate-oval, and formed by the swelling of a twig to 2 or 3 times its former diameter, the swelled portion being very much contracted longitudinally, so as to bring each kernel-like bud nearly or quite into contact with the base of the one that precedes it in the same row, the whole number being arranged in 4 irregular rows. Besides the swelling of the twig itself, the origin of each bud is also swelled into a more or less large tubercle, inside which is excavated longitudinally a cylindrical, slightly rugose and moderately polished cell, .25—.27 inch long and .06 inch wide, the bud itself being elongated to about .17 inch and deformed so as to become a beak-like, tubiliform continuation of the cell, without any suture on the inside intervening, moderately polished inside like the woody part of the cell, and without pubescence as at the interior tip of the cell of *S. cornu* n. sp. Through a slit at the tip of this beak-like bud the maker of the gall escapes, while, as usual, the parasite that preys on the gall-maker bores through it laterally. Above the gall the twig generally shrivels to about ½ its natural diameter, but occasionally where there are only a few cells—say 7 or 8 instead of 15 or 16—it is not very materially diminished in size.—Described from 3 dead and dry specimens. Very rare near Rock Island.

LARVA, PUPA and IMAGO are all unknown; but from the structure of this gall being so exactly like that of *S. siliqua* n. sp.? and especially *S. cornu* n. sp., there can be no doubt that it is, like those two galls, the work of a *Cecidomyia*. Inside several of the cells I found cocoons similar to those of *C. s. strobiloides*, &c., but much longer in proportion to their diameter, and not glued to the walls of the cell as in *S. siliqua* and *S. cornu*, so that I was able after relaxing the gall to extract two of them entire. They measured when extracted .42—.44 inch in length and .06 inch in diameter, thus occupying the entire length and breadth of the cell including the beak formed by the bud. In the bottom of many of these cells, where the beak-like bud was bored laterally, I found an empty cocoon very similar to that of a parasitic

Proctotrupide which occurs in the imago state in November in the central cell of *S. strobiloides* O. S.; and in these cells there was no Cecidomyidous cocoon, as is also sometimes the case in the cells of *C. s. strobiloides* that are occupied by the above Proctotrupide.

No. 10. Gall S. HORDEOIDES n. sp.—On S. humilis. This gall has some resemblance to a beardless ear of four-rowed barley, and differs as follows from *S. triticoides*:—1*st.* The twig on which the cells are placed is not materially enlarged and is of a uniform diameter throughout. 2*nd.* The twig is abnormally shortened as in *S. triticoides*, but only so that the tip of each deformed bud touches or nearly touches the base of the one that succeeds it in the *adjoining* row, instead of the base of the one in the *same* row. 3*rd.* The entire cells are only .20 inch long, instead of .42—.44 inch, and they extend only .05 inch, or ¼ of their entire length instead of 3-5ths of their entire length, into the woody origin of the bud, the deformed buds being not much elongated, but hollow and, as well as the woody part of the cell, polished internally. 4*th.* The woody origin of the buds is scarcely swelled and protuberant.—Described from one dead and dry specimen, 1.40 inch long and .10 inch in diameter. It contains 10 deformed buds, regularly arranged with no undeformed ones intervening, as is the case in the monothalamous gall *S. cornu*, when several of them grow near each other. As in some *S. triticoides*, the tip of the twig has completely shrivelled up and perished. Easily distinguished from the monothalamous, Tenthredinidous gall, *S. gemma* n. sp., which occurs on the same Willow, by there being no normal buds between the affected buds, and by the buds themselves not being abnormally swelled out laterally, and being hollow, not solid, inside. But for the fact of several of the deformed buds having been bored by minute parasites, I should never have suspected this specimen of being what it most undoubtedly is—a true Cecidomyidous gall; and but for its strong homologies with *S. triticoides*, I should hesitate whether to consider it as a congeries of solitary galls, like *S. cornu*, or a true polythalamous gall, where the twig itself is swelled and deformed and converted into a gall, like *S. triticoides*. It must be very difficult of discovery, when it is recent and the cells are unbored by any parasites.

LARVA, PUPA and IMAGO unknown.

No. 11. **Gall S. nodulus**, n. sp.—On S. longifolia. A small, monothalamous, woody gall, sometimes terminal but generally not so, scarcely ever including

any buds, growing on twigs .05—.15 inch in diameter, variable in shape, but generally consisting of a mere oval enlargement of the twig to half as large as its normal size for the length of .20—.50 inch. The surface of the enlargement is either the usual color of the bark, or simply discolored and dark, or a little roughened with brown scales and longitudinally sinuate and interlacing striæ. Occasionally it assumes the form of an elongate, lateral, bunnion-like swelling about .27 inch long and .13 inch wide, as in some varieties of *S. batatas* n. sp., and in one specimen there occurred an intermediate grade between this variety and the normal type; occasionally it grows at the base of a very small side-shoot, when the tip of the side-shoot shrivels up and perishes; and occasionally the growth of the side-shoot is completely arrested, and the gall becomes a mere obhemispherical swelling about .20 inch in diameter, with its upper surface in an irregular plane, and very rugose and brown, located at the spot where normally there ought to be a bud. On cutting into this gall in November, it is found to contain a single cell—smooth on the inside when the gall-making larva is present, but, as in *S. batatas*, without any separate cocoon—and much reddish-brown matter where the larva had formerly burrowed, and occasionally some grass-green soft matter: but the external walls are still in their normal white, ligneous state, the larva having apparently confined itself to the pith and the wood immediately surrounding the pith.

Described from 9 specimens. Rare near Rock Island. Externally this gall cannot be distinguished from the smaller varieties of *C. batatas*, but the former is monothalamous, the latter polythalamous; neither can it be distinguished, except by its much smaller size and its much smaller cell, from the Tenthredinidous gall *C. nodus* which grows on the same willow. Of the 9 galls examined, 7 were unbored, 3 of which contained each a single larva of *Cec. s. nodulus*, 1 a single hairy Chalcididous larva, probably a *Callimome*, 1 a single Curculionidous larva, no doubt an Inquiline, and in 2 the gall-making larva was absent and must have perished in early life, for although its work was plainly visible yet the gall was not bored. In none of the 9, whether bored or unbored, had the twig been killed, except in the very small gall before referred to, where the terminal bud had sprouted out into a minute shoot which afterwards perished. The smallness of this larva and there being only one in each gall, readily account for this otherwise anomalous fact.

I found Dec. 1st in one of these galls, which had been bored by a single hole and contained no Cecidomyidous larva, a minute Lepidopterous larva, doubtless an inquiline, and over a dozen small and young *Aphis*, which had probably taken refuge there for the winter. May not Hartig have been deceived by some such case as this into suppos-

ing, that certain European Willow-galls were the work of *Aphis?* (See above, p. 551.) On July 31st I found a bored and empty specimen of the Tenthredinidous gall *C. pomum* tenanted in the same manner by over a dozen *Aphis*.

Larva. The larva in November is of a bright, shining, orange color, immaculate, with the segments much hunched, .07—.10 inch long and from 3 to 4 times as long as wide. The breast-bone is clove-shaped and exactly like that of *C. batatas*, but on comparing 10 specimens of that species there can be no doubt of their specific distinctness. For the larva of *C. s. nodulus* differs from that of *C. s. batatas*, 1st in being much more elongate, 2nd in being immaculate with sanguineous, 3rd in being unusually shining and the segments more hunched than in any Willow-gall *Cecidomyia* known to me except *C. s. siliqua*.—Described from 3 specimens.

Pupa and imago unknown.

No. 12. **Gall s. batatas** n. sp.—On S. humilis, (S. cordata? and S. discolor?) A polythalamous gall of very variable shape and size, pale green when young, the color of the bark when mature, growing on twigs .06—.19 inch in diameter, almost always some distance from the tip of the twig. Sometimes it resembles a small kidney-potato pierced lengthways by a twig, and has then most generally a smooth, polished surface studded with a few buds, one or two of which occasionally give birth to a shoot, and it then reaches 1.35 inch in length and .60 inch in diameter. Sometimes it resembles a young apple pierced lengthways by a twig, and it then attains a diameter of .50 inch. Sometimes it forms a hemispherical or hemielliptic swelling, like a bunnion, on the side of the twig and attains a diameter of .30 inch. Sometimes all these different shapes are strung together one after the other in more or less close proximity, on the same twig. Sometimes it is reduced to a small, elongate-oval enlargement of the twig for ½ or ¾ an inch; and occasionally it becomes so irregular and so full of side-shoots, bulges, cracks, roughnesses and lobes, as to defy description. Very rarely it is terminal and assumes the form of *S. siliqua*, but may be distinguished by the terminal bud not being elongated and tubiliform, and by being solid and not hollow inside. On one occasion I found what had evidently been a *S. siliqua* gall, occupied laterally by spongy matter containing 4 larvæ undistinguishable from those of *C. s. batatas*, the elongated cell of the larva of *C. s. siliqua* being still in existence but contracted in diameter and empty. When these galls assume the elongate bunnion-like form, they are undistinguishable externally from the Tenthredinidous gall *S. ovum*, which occurs on S. cordata, and *S. ovulum*, which occurs on the same willow as *S. batatas*, but may be distinguished on cutting into them by the fibres being linear and radiating from the twig, whereas the other two galls are composed of a series of spongy lamellæ at right angles to the axis of the twig, and moreover, when laid open to their base, ex-

hibit the longitudinal slit made by the ovipositor of the mother Saw-fly. The smallest galls above referred to are only .15 inch in diameter; but there is a regular gradation from these to the larger and more conspicuous forms, and by isolating a number of the first in a separate breeding-jar, I ascertained that they produced the same *Cecidomyia* (7 specimens April 7—May 10) and the same 3 parasites, viz. 2 Chalcidides and 1 Proctotrupide. When cut into about the last of July, the interior of this gall to the depth of .07—.10 inch from the surface, is found to be white and fleshy: when cut into in the autumn or early in the spring, the substance of all but the very smallest, which are almost entirely woody and whitish, is found to be reddish-brown and of a dense, spongy texture, with indistinct fibres radiating from the twig. Some little distance from the external surface there are at this time a number of cells, about ¾ of them tenanted by white, parasitic larvæ, some hairy and some glabrous, belonging to the Chalcididous genera *Callimome* and *Decatoma* (?), and about ¼ of them tenanted by the orange-colored larvæ of the Gall-gnat which originates the gall. In 3 or 4 instances I have seen the gall *S. gnaphalioides* growing sessile from the tip of *S. batatas*.—Described from 100—150 specimens. Very common near Rock Island on S. humilis.

In galls similar to the last mentioned, small, elongate-oval galls, but growing on S. cordata, I found May 9 a larva undistinguishable from that of *C. s. batatus* and with the same breast-bone, but did not succeed in breeding the perfect Gall-gnat, though I obtained many *Chalcididæ* from these galls identical with two species bred copiously from *S. batatas*, one of which—a Decatoma (?) with spotted wings—has hitherto occurred in no other gall, though a similar species infests *Cynips q. spongifica* and other gall-flies.

In November I found on *S. discolor* 8 galls, apparently identical both externally and internally with the *S. batatas* found on *S. humilis*, 3 old and dry ones of the normal form which were all bored and strung along on the same twig, and 5 green and recent ones of the lateral, bunnion-like type on two different twigs. Their diameter was .19—.40 inch. From the recent ones I obtained 6 larvæ, which when compared with 6 taken from galls on S. humilis differed in no respect. In the preceding spring I had obtained 2 or 3 similar galls of the bunnion-like type from the same bush, from which I bred a large *Microgaster*, whence I infer that some lepidopterous larva had been living as an Inquiline in one of them, as the parasite was much too large to have lived in the body of *C. s. batatus*, and besides I have met with no instance of Ichneumonidous insects being parasitic on *Cecidomyia*. I found at the same time several galls on the same bush, which, as has been stated to

be sometimes the case in *S. batatas*, assumed the form of a slight, elongate-oval enlargement of the twig; but from these I bred nothing. On the whole, further investigation will be required to determine, whether the imago produced from these galls on S. cordata and S. discolor is identical with *Cec. s. batatas*. It is rather singular, that in these S. discolor galls I found no larvæ at all of the Decatoma (?) and Callimome, which so greatly outnumber the larvæ of *C. s. batatas* in the S. humilis galls.

It is worth remarking, that the only two Cecidomyidous galls which appear to grow on more than one species of our Rock Island Willows—viz. *S. batatas* and *C. siliqua*—occur on as many as three species of them, and that these three species should in both cases be the *same* three, viz. S. humilis, S. cordata and S. discolor. The chances are very greatly against such an event happening, without some good and sufficient cause for it. Mr. Bebb informs me that there is a close alliance between S. humilis and S. discolor; but that neither S. cordata (=S. rigida) nor S. lucida is allied to the first two. While on this subject I may say that Mr. Bebb has re-examined the doubtful species of Willow referred to above (p. 546), and has concluded that it is certainly neither S. nigra nor S. alba, and that it is not improbably S. fragilis Lin., a species which has been introduced into N. A. from Europe.

Larva.—July 24 and 30 the larvæ were orange-colored, .09 inch long and with a slender, black, clove-shaped breast-bone, and some of them with curdy, bowel-like markings above and below. The surface of the cell was then opaque and rather rough and scaly. Nov. 11 and subsequently the surface of the cells was smooth, the cocoon apparently adhering to their sides but being scarcely separable except piece-meal. Larvæ from 12 to 20 in number examined at various times in November were .08—.10 inch long and .04—.05 inch wide, not shining but rather opaque as in most of the preceding, except *C. s. nodulus*, of a sanguineous color with dominant, bowel-like, yellowish markings, which are situated mostly between the sutures, the sanguineous color generally forming a wide dorsal vitta, widely interrupted between the sutures on each joint. Breast-bone coal-black, clove-shaped, the head of the clove towards the mouth, 1-4—1-5 as long as the whole breast-bone and composed of two short, robust, acute branches, which are divergent at base but afterwards run parallel to each other, with an appearance often of another lateral branch on each side. The stem of the clove is straight, uniform in breadth except that it is minutely clavate at base, and 4—5 times as long as broad; and the whole breast-bone is half as long again as one of the middle abdominal joints. Feb. 26 and 28 the insect was still in the larva state, and was then deep orange-color almost sanguineous: and a specimen occurred in that state even as late as April 23.

Pupa.—The first pupæ were found March 16 and others were noticed up to April 15. Those first noticed were all bright sanguineous: the last, which were probably just about to transform, had the abdomen dull luteous and the rest of the body, including the legs, blackish. The horns at the base of the antennæ are long, elongate-conical, about ½ as long as the diameter of the thorax, diverging from each other at an angle of about 45° and terminating in a short thorn. The thoracic bristle is ½ as long as the diameter of the thorax, and is both in the living and the dried specimen basally whitish but terminally black.—Length (1 specimen, dried) .10 inch.

The pupal integument (21 specimens) is whitish, the head and antennæ, but not the wing-cases, very slightly tinged with dusky, and the thoracic bristles and the tips of the antennal horns conspicuously black. The pupa, just before transforming into the imago, works ½ its body out of the gall and generally transforms in that position, but sometimes loses its hold and falls entirely out. The horns at the base of the antennæ are no doubt elongated in this species, and as shown by their color in the pupal integument terminally thickened, to enable it to bore its way out through the sponge of the gall, whereas all the preceding species, with the single exception of *C. s. nodulus*, the pupa of which is unknown, merely have to bore through the filmy substance of their cocoons. They are still longer and in the pupal integument entirely black in the inquilinous *C. cornuta* n. sp., which has to bore its way out through the wood of the willow twig in which it resides.

Imago. C. s. batatas n. sp.—♂ ♀ (Recent.) Pale reddish-brown, or reddish-brown, or umber-brown, or brown-black, paler beneath. *Head* with its posterior surface dusky; antennæ ♂ about ¾ as long as the dried body, 18—19 jointed (2+16 to 2+17), the last 2 or 3 joints without any distinct pedicel, the antenna otherwise constructed precisely as in ♂ *C. s. brassicoides*. Antennæ ♀ not quite ⅓ as long as the dried body exclusive of the oviduct, with apparently a joint or two less than the ♂, the joints difficult to count, otherwise as in ♀ *C. s. brassicoides*. *Thorax* with a row of whitish hairs in each longitudinal stria, giving the appearance of two whitish vittæ, and with irregular lateral whitish hairs, the three interstices glabrous. Origin of wings and a large spot beneath them orange-color or sanguineous, in the dried specimen dull rufous. Halteres pale, the club often a little obfuscated. *Abdomen* ♀ above and below sanguineous with short whitish hairs and generally a lateral subterminal tuft of longer whitish hairs on each joint of the dorsum; sometimes in the more mature specimens with a broad vitta of short, brown hairs covering nearly the entire dorsal surface and the lateral hairs whitish with a definite dividing outline; sometimes with the sanguineous color of the entire dorsum completely concealed, except at the sutures, by short, brown hairs and the oviduct also brown. Oviduct sometimes protruded so as to be ¾ as long as the other part of the abdo-

men, sometimes so as to be only ½ as long. Abdomen ♂, unless my memory fails me, luteous when recent, otherwise much as in ♀. *Legs* (dried) silvery white or yellowish white with the superior surface, especially towards the knees, and also the tips of the tarsi, sometimes strongly, sometimes scarcely, blackish. *Wings* slightly tinged with dusky from minute, appressed, dusky hairs, in 3 ♀ (both recent and dried) tinged with brown throughout, in 2 ♀ (both recent and dried) tinged with brown towards the tips. The costal vein generally coarse and brown black, sometimes finer and the color of the wing. The cross-vein between the 1st and 2nd longitudinal veins obsolete. The 2nd longitudinal vein scarcely recurved at its tip. The anterior branch of the 3rd longitudinal vein distinct throughout, and springing from that vein at an angle of about 135° for a very minute distance, when it suddenly curves round and assumes such a direction, that it appears at first sight to be a continuation of the main vein rather than a branch of it; and it is scarcely recurved at tip, proceeding nearly in a straight line, till it almost attains the margin, when it fades out.—Length (dried) ♂ .08 inch, ♀ (including oviduct) .10—.18 inch. Length wing ♂ .13 inch, ♀ .11—.13 inch.

Two ♂, forty-one ♀. In this species, unlike all the preceding, the abdomen ♂ ♀ retains its colors very tolerably in the dried specimen. The ♀ ♀ very greatly outnumbered the ♂ ♂, and the ♀ ♀ came out April 8—May 10 and subsequently, and what is unusual in insects the ♂ ♂ not till long after the ♀ ♀, or the last of April and the beginning of May. Mr. Edwards has remarked to me that in many species of butterflies the ♂ ♂ make their first appearance several weeks before the ♀ ♀, and I have observed the same thing myself, not only of several butterflies, e. g. *Nathalis Iole* Bdv., but of many other insects belonging to different Orders, and believe it to be a general, though by no means a universal rule. This species differs from the inquilinous *Cec. albovittata* n. sp., which infests this as well as several other Willow galls, in its much larger size, and in the ♂ antennæ being 18—19-jointed instead of 14—15-jointed, and in the comparative shortness of their pedicels. In other respects the two species, even when recent specimens are placed side by side, cannot be distinguished, except by a recondite character in their venation. From the inquilinous *C. orbitalis* n. sp., which infests this and several other Willow galls, it is easily distinguishable when recent by the posterior surface of the head being uniformly dusky and showing no white ring round the eye. From both species the pupa is at once separated by the very elongated horns at the base of the antennæ. My other inquilinous species are quite distinct.

I have observed in two successive autumns, that many of these galls, especially the large, potato-like ones, are already bored by holes of the same size as those made by *C. s. batatas;* and on placing a large number of such bored galls next spring in a separate breeding-jar, I obtained from them in considerable numbers the same 3 parasites which I bred at the same time in very large numbers from the unbored galls, but no *Cecidomyia*. Hence I infer either, 1*st*. that a few *C. s. batatas* come out in the autumn and the rest not till the following spring, which actually occurs with the Wheat-midge, (see above p. 568), and is a common thing with many other insects, or 2*nd*. that the species is double-brooded like the inquilinous *C. albovittata* n. sp., which is contrary to the analogy of the other Gall-gnats of the Willow and does not harmonize with the fact of the bored and unbored galls producing the same identical 3 parasites, or 3*rd*. that there is some parasite or inquiline, hitherto undiscovered by me, which infests these galls and whose natural time for assuming the imago state is in autumn. Of these three hypotheses, which are all possible, I decidedly incline to the first.

No. 13. **Gall S. verruca**, n. sp.—On S. humilis. A small, monothalamous, irregularly spherical, greenish yellow gall, .07—.13 inch in diameter, growing the latter end of August from the midrib or some of the principal veins of the leaf, half of it projecting from each side of the leaf. The upper side is flattish or with a minute point or nipple, the lower side branches out into a ragged, wart-like excrescence, whence the specific name, which later in the season bursts open so as to afford an exit to the insect. When cut into in August, the external wall of a few galls is found to be rather woody, enclosing a central cell, in which lies the larva; but the majority of them are still solid. From 1 to 12 are found on a single leaf, several of them being often confluent, but with their internal cells, when they have any, separated by a thin partition, and with separate warts to each on the under side of the leaf, which afterwards open separately. Rather abundant, but local near Rock Island. Described from 38 affected leaves.

Larva.—By August 26th, in a few of the galls, the larva is .07 inch long, of the usual oval shape, orange-colored, and with the breast-bone suborbicular, small and indistinct. In the others the larva is not developed, nearly the whole interior of the gall being solid. Those that I attempted to breed all dried up inside the gall before November, the leaves having been kept too dry; but from the structure of the gall itself and the analogy of similar Cecidomyidous galls on the oak, (*Symmetrica* O. S. and *Quercus pilulæ* Walsh,) I infer that they go under ground to transform into the pupa state.

PUPA and IMAGO unknown.

No. 14. **Gall S. semen**, n. sp.—On S. nigra. A minute, monothalamous, hol-

low, irregularly hemispherical, greenish yellow gall, .02—.04 inch in diameter, mostly on the upper side of the leaf, and often, but not always, with a pointed nipple on the middle of the hemisphere, always with a corresponding circular depression on the other side of the leaf, in the middle of which is a very minute, flattish hemisphere. Very frequently on one and the same leaf the position of the gall is reversed from the upper to the lower side, as in *Q. pilulæ* Walsh. On a single leaf scores of them may often be counted, generally with several masses among them, composed of two or more confluent galls. Commences its growth early in the summer, and by the last of August many are found to be burst open at top, yet at the same time very many of them, when opened, are found to be solid without any central cell. By November most of the galls from which I attempted to breed the insect had burst open into a ragged, wart-like shape on the hemispherical side, but no larvæ had escaped from them and none were discoverable in them. As the leaves were kept too moist, so that they moulded badly, the larvæ had probably perished in the galls.

Described from 20 affected leaves. From its close homology with the much larger oak-galls *Symmetrica* O. S. and *Q. pilulæ* Walsh, in the former of which Cecidomyidous larvæ were detected by Osten Sacken, and described (*Dipt. N. A.* p. 201) as having a Y-shaped breast-bone, and in the latter of which I found myself, September 14th, several orange-colored larvæ, which, from the presence of a clove-shaped breast-bone, were undoubtedly Cecidomyidous, and from the fact of a similar leaf-gall on a Willow, *S. verruca* n. sp., being inhabited by a Cecidomyidous larva, there can be no doubt, I think, that the gall *S. semen* is the work of a Gall-gnat. Prodigiously abundant and very common everywhere in Rock Island County, Illinois, on the Black Willow, the foliage of whole trees being thickly frosted over by it, so that the leaves look like nutmeg-graters. I have in a cursory manner noticed in July several specimens of what seemed a very similar gall on S. discolor, but found no larvæ in them; and in a single instance I found, August 20, two leaves of S. longifolia on a twig which grew out of a bunch of the galls *S. brassicoides*, covered so densely with somewhat similar galls as to be intermediate in appearance between *S. semen* and *S. ænigma*. On August 29 I discovered in one of the cells of this gall a minute, pale-colored, apod larva with a large, scaly head, and the disk of its dorsum, but not of its venter, fuscous. This so exactly resembled a much larger larva of which I have found many specimens in the Cecidomyidous gall, *Q. pilulæ* Walsh, and which I am sure, from comparing it with the larva of *Anthonomus scutellatus* Schönh., must be Curculionidous, that I believe it to be also Curculionidous,

and inquilinous, like the other larva, in the gall where it occurred.

I have noticed towards the last of August galls about the size of the head of a large pin, similar to *S. semen*, and often similarly confluent, growing in considerable abundance on the leaves of the River Birch (Betula nigra), chiefly or almost entirely on their upper surface. And on the leaves of the Button-bush (Cephalanthus) I have noticed at the same period of the year galls of the same character, in the same luxuriant profusion as *S. semen* occurs on the Black Willow, whole bushes being covered with them; but in neither of the two kinds could I discover any larvæ. I believe them both to be the work of *Cecidomyia*. It does not follow, because all these galls are so small, that therefore their Gall-gnats must be abnormally small. The gall *S. rhodoides* n. sp. is about 4 times as long and wide as the Gall *S. gnaphalioides* n. sp., yet the Gall-gnat produced from the latter is only ¼ shorter than the Gall-gnat produced from the former.

LARVA, PUPA and IMAGO unknown.

No. 15. **Gall S. ænigma**, n. sp.—On S. nigra. A polythalamous, crumpled, irregularly spherical or ellipsoidal mass, something like the aborted mass of flower-buds of a common cauliflower, but with a more ragged and uneven surface, .30—1.10 inch in diameter, and growing almost sessile or sometimes on a stem as long as .50 inch, which is often branched and much flattened or distorted, from the side or occasionally from the tip of twigs .05—.30 inch in diameter. When cut into early in the summer, there is seen to be no regular heart or symmetrical arrangement of the parts, as there is in all monothalamous galls, and the stem is crisp and rather fleshy than woody. This gall first appears early in June, being chiefly a deformation of the flower-catkins, but occasionally, unless I was deceived from confounding it with *S. semen* n. sp., which I think must have been the case, of the leaves. At that time, and for a month or two afterwards, it is of a pale green, but long before autumn it dries up and becomes brittle and of a dark ash-gray color, without, however, losing its original shape, and hangs on the trees till long after the next spring opens. It contains, so far as I could discover, no regular cells, but the larvæ of the Gall-gnat appear to burrow irregularly in the main stem and its branches. On the same twig may often be seen 6 or 8 of these galls at irregular intervals of half an inch or 1½ inches, and frequently two of them grow side by side and run together. Whole trees are sometimes so covered by them, that the galls seem almost half as numerous as the leaves. As usual, the twigs, unless very large, are killed by the presence of these galls shortly after the galls have become mature. Described from 150—200 specimens. Very common and abundant everywhere in Rock Island County, Illinois.

LARVA.—On June 19 the larva, or what I took to be the larva, of the gall-maker was small and barely visible in the stem of the gall, but

the place where it worked was discolored and brown. On August 19, from about half a gallon of galls, which had been gathered only 5 or 6 days before, there came out about a dozen larvæ, apparently with the intention of going under ground, and after some considerable search I discovered one inside the substance of the stem of a gall. No others came out subsequently, so far as I observed, from that large mass of galls; and if many of them had come out they could scarcely have escaped notice, for there was nothing in the breeding-jar but the galls themselves, and no earth at the bottom of it. Those that came out were .05 inch long, rather elongate, and with the head more porrect and pointed than is usual, except in the larvæ of *C. s. siliqua* and *C. s. nodulus*. The breast-bone was rather indistinct, but seemed to be about twice as long as its basal width and tapered to $\frac{1}{2}$ the basal width at tip. Repeatedly at other times during the season I had cut into these galls, both at home and in the field, and always failed to find Cecidomyidous larvæ in them, though I sometimes found that of an inquilinous Lepidopteron. It is possible that the above larvæ might also have been inquilinous; but if so, where were the *Cecidomyia* that really made the galls? I am persuaded that the gall is really Cecidomyidous, because, 1*st*, I obtained from them the same Lepidopterous imago that I obtained in great numbers from the Cecidomyidous gall *S. brassicoides* n. sp.;* 2*nd*, I noticed on them in considerable numbers, and both in the larva and imago states, the same Heteropterous insect—*Anthocoris pseudochinche* Fitch—that occurs also in great numbers on the Cecidomyidous gall *S. brassicoides* n. sp., and in less numbers on the Cecidomyidous galls *S. rhodoides* n. sp. and *S. strobiloides* O. S.; 3*rd*, As already stated (p 551) I believe that all Willow Galls are either the work of Gall-gnats or of Saw-flies, and the larvæ of Saw-flies being comparatively large and conspicuous, if *S. ænigma* was a Tenthredinidous gall I must have found some Tenthredinidous larvæ in it, so often as I dug into it; whence by the method of exhaustion it follows that it must be a Cecidomyidous gall.—As on June 19 I noticed on these galls the larva of a large *Thrips*, and a few others subsequently in the imago

*The species here referred to belongs, according to Dr. Clemens, to *Tortricidæ*, but has not as yet been described by him. It is remarkable for varying in the most surprising manner, and I sent Dr. Clemens a very large series of all the variations.

state, it is not improbable that this insect may puncture and destroy the great majority of the *Cecidomyidæ*, that originate the gall, either in the egg or the very young larva state, for which purpose its very elongate, horny, setiform mandibles, which Haliday described as "having a bulbous base and by their junction towards the tip forming a 2-valved siphon," seem to be admirably adapted. (See Westw. *Intr.* II. p. 2 and p. 1. fig. 4.) The whole subject of the great paucity of Cecidomyidous larvæ in this and other allied galls is a mystery at present, and requires further and fuller investigation. The only other insects that I noticed on or in these galls, besides those already referred to, none of which could be insectivorous, were a single Coleopterous (?) larva, pedate and ½ an inch long, on August 17, which I failed to rear to maturity, and a single imago of the Coleopterous *Litargus 4-spilotus* Lec., which I bred from them on August 30, and which evidently could not have been insectivorous. It is proper to add, that I did not replace the galls in my breeding-jar during the summer by fresh specimens so often as I should have done, in order to become thoroughly acquainted with their Natural History; and that it is therefore quite possible that a considerable number of larvæ may have escaped from the galls on the trees shortly before August 14. (See above p. 574.)

It is well known that Economic Entomologists have been greatly exercised, to account for the cause of the affection of the leaves of the Peach-tree known in the East as "the curl." Some have attributed it to the action of *Aphis*, and others partly to *Aphis* and partly to other unknown causes. (Harris *Inj. Ins.* p. 240, and *Rep. Pomolog. Soc.* p. 4; Fitch *N. Y. Rep.* II. p. 63.) I am myself unacquainted with the phenomena of "the curl," as the disease does not appear to prevail in the Valley of the Mississippi; but Harris describes it as "irregular and crisp tumors, often of a reddish color and of a spongy texture, formed of thickened and succulent cellular tissue, and presenting some analogy to the warts [Black-knot] of the Plum-tree." (*Rep. Pom. Soc.* p. 4.) May it not be possible that it is a polythalamous gall like *S. æniyma* n. sp., and like that gall the work of a *Cecidomyia?* It presents some rather striking analogies with certain galls known to be Cecidomyidous 1*st*. As in *q. pilulæ* Walsh, the tumors are red. 2*nd*. As in that gall and in *S. verruca*, *S. semen* and *S. æniyma*, the great majority of the tumors, when opened, even at a late period of the year, are solid and

contain no cell and no visible larva. What is the cause of this phenomenon I cannot say with certainty, but I suspect that the egg or the very young larva of the Gall-gnat is to a great extent destroyed within the gall by being punctured and sucked by some insect foe, and that that foe probably belongs to *Thripidæ*.* Authors have hitherto always considered this remarkable Family as vegetable-feeders, but from many facts which I have observed, one of which I have recorded *Proc. Ent. Soc. Phil.* I. p. 310, I believe that they are generally, if not universally, insectivorous, and that those that occur on the ears of the wheat, both in the U. S. and in Europe, are preying there upon the eggs or larvæ of the Wheat Midge (*Cec. Tritici*), and are consequently not the foes, as has been generally imagined, but the friends of the farmer. In confirmation of these views, it may be remarked, that the very same species (*Thrips cerealium*), which has been stated by all European authors to attack the *ears* of the wheat, was found by Vassalli Eandi in Italy "to gnaw the *stems* of the wheat above the knots and cause the abortion of the ear." (See Westw. *Intr.* II. p. 4.) Is it probable that the same species should attack the same plant in two such very different parts? I believe that the Italian *Thrips* were attacking Hessian Flies (*Cec. destructor*), or some such wheat-destroying insects that inhabit "the stem above the knots," and that it was these last, and not the *Thrips*, that caused the "abortion of the ear." The *Thrips* that were supposed to do so much damage in Wisconsan, as related by Dr. Fitch. (*N. Y. Rep.* I. p. 304), were said to attack both the blossoms of the wheat

*Dr. Fitch, perhaps because Dr. Harris had seen fit to alter the *Aphidæ* of preceding authors into *Aphididæ*—which may or may not be right, according to whether we consider the analogies of the noun *Aphis* to be with the Greek *Chrysis* or with the Latin *Apis*—asserts that the *Thripidæ* of preceding authors is incorrect and ought to be written *Thripididæ*, and adopts that anomalous orthography himself. (*N. Y. Rep.* I. p. 305.) Scientific names are generally sufficiently long, without interpolating unnecessary syllables, and in this case the interpolation is manifestly not only unnecessary, but solecistic. *Thrips* is a genuine Greek word, with a genitive case *Thripos*, from which is regularly derived the patronymic form *Thripidæ*, just as from the Greek noun *Sphinx*, genitive case *Sphingos*, comes the patronymic *Sphingidæ*. We might as well write *Sphingididæ* as *Thripididæ*. It is true these are trivial matters: but when an author undertakes to set the whole scientific world right, even on the most trivial point, he should first take care to be himself in the right.

and the blossoms of the clover. But it is not the general habit of Insects to prey at the same time upon two plants, which are so widely distinct as wheat and clover—the one monocotyledonous, the other dicotyledonous. Even the polyphagous Army-worm refuses to eat clover. *3rd.* The "curled" peach-leaves are said to be commonly inhabited by a *Thrips*, but not in sufficient numbers to account for the presence of the "Curl." (Harr. *Inj. Ins.* p. 240.) Now, as already stated, I have myself noticed several *Thrips* in June both in the larva and imago state on the Cecidomyidous gall *S. ænigma*, and have raised the larva to maturity in a breeding-jar in which there was nothing but that gall. Moreover, Dr. Fitch found his *Phlœothrips caryæ* in hickory galls, which are manifestly either closely allied to or identical with the Cecidomyidous hickory gall *Tubicola* O. S., though he doubts whether those galls were produced by the *Thrips* or by some other insect. (*N. Y. Rep.* II. p. 165.) And Osten Sacken observes of the galls of the Cecidomyidous *Lasioptera vitis* O. S., that "some of the hollows are often abandoned by their inmates and invaded by numerous *Thrips*." (*Dipt. N. A.* p. 201.)

There are more insectivorous groups in Insecta than are commonly supposed. I have caught *Listotrophus cingulatus* Grv. (*Coleoptera*), which habitually haunts cow-dungs and carrion, with a large *Hister* in its mouth, and I believe, from sundry other facts, that in *Staphylinidæ*, which used to be all of them grouped as *Rhypophaga* or Dirt-eaters, the tribes *Staphylinini*, *Pæderini*, and probably *Stenini* and *Oxytelini*, are all generally insectivorous; while I know from having bred them, that some and probably all *Omalini* are fungivorous, and suspect that *Aleocharini* and *Tachyporini* are also "dirt-eaters." Again, I have often wondered that for seven successive years the number of the web-nests of *Hyphantria textor* Harris (*Lepidoptera*) remained, from year to year, an invariable quantity near Rock Island, neither increasing nor diminishing, though the number of eggs laid by each ♀ must be represented by the number of larvæ in a nest, which is very large. The larvæ can scarcely be preyed on to any very great extent by the ordinary Dipterous and Hymenopterous Parasites nor by birds, for they are effectually protected the greater part of the time by their impenetrable nests; and the Coleopterous genus *Calosoma*, which is known to prey on social caterpillars, is exceedingly rare near Rock Island. This autumn the

mystery was partially solved. I found September 26 in a great many of their nests numerous *Rhaphigaster* n. sp. (?) (*Heteroptera*), both in the pupa and imago states, along with great quantities of their exuviæ; and suspecting them to be there on no friendly errand, I confined four of them in a breeding-jar, where I had a large brood of young Aretians raised from a mass of eggs and feeding on wild mulberry leaves. Within the next few days I had the pleasure of seeing one of them, on two separate occasions, with its beak porrect and plunged into the body of an unfortunate Arctian larva, and the sucked carcass of another one lying by its side. I had previously in August found 6 or 8 *Tetyra fimbriata* Say in the web-nest of another lepidopterous larva. Hence I infer that *Scutelleridæ* are generally insectivorous; for the *Rhaphigaster* had evidently, from the numbers of their exuviæ, been inhabiting the nests of *H. textor* for a long time. Some instances of their insectivorous habits are recorded by Westwood, though he states also that they live upon sap, "introducing their rostrum into leaves," which I have never seen them do. (*Intr.* II. p. 486.)

So much for the "Curl" on Peach-trees. There is another gall-like excrescence popularly known as the "Black-knot," and very abundant on the wild and cultivated Plum and occasionally found on the Cherry, which has been a similar *Crux Entomologorum*. Unlike the "Curl" this is just as common in the Valley of the Mississippi as it is said to be in the Eastern States, but I have never watched it through the earlier stages of its progress, and know it only in the mature and dry specimen. Dr. Fitch describes it as "commencing upon the small limbs, and to be recognized at first by a slight swelling of the bark on the upper side of the limb, which begins in autumn and remains stationary through the winter. In the spring this swelling increases, rupturing the cuticle and thin outer skin of the bark, and continuing to grow and puff out, till in June some inches in length of the limb at the place affected is three or four times its diameter elsewhere. Both the bark and woody fibres are changed into a *spongy substance*, not at all juicy like the fruit of a tree, of a pale yellow color when growing, but changing to coal-black when it is mature." (*Rep. Curculio and Black-Knot*, 1860, p. 21.) Although Dr. Fitch states that he "has examined these excrescences more closely, perhaps, than has ever been done by any other person," and that he is "prepared to say with the fullest confidence,

that the microscope shows nothing about them, externally or internally, indicating that an insect has anything to do with causing them," and maintains that they "are not of insect origin, nor a vegetable fungus, but are properly a disease of the tree, analogous to the cancer in the human body." (*ibid.* pp. 21—2.) yet I cannot help believing that the "Black-knot," as well as the "Curl," is the work of Gall-gnats. It is perhaps presumptuous in one who has never specially investigated the subject, to set up his own opinion against that of a distinguished naturalist who has devoted considerable attention to it; but there is an old saying that "bystanders sometimes see more of the game than the players themselves," and it may be the case that a general acquaintance with many allied species can sometimes supply the place of the most laborious special investigations.

My reasons for the belief which I have just avowed are the following:—1*st*. Just as Curculionidous larva are inquilinous in the Cecidomyidous galls *Q. pilulæ* Walsh and *S. semen* n. sp. and others are inquilinous in the galls of other Gall-gnats, (see above p. 607, and below under *Coleoptera*), so the common Curculio (*Conotrachelus nenuphar* Hbst.) is notoriously inquilinous in the Black-knot. Dr. Fitch, for example, says, that the "larvæ of the Curculio are almost always found in them" (*Rep. Curc. and Bl. Knot*, p. 21), and Harris says that they are "sometimes" found there (*Inj. Ins.* p. 80.) Again, just as I have bred 8 distinct inquilinous Lepidoptera from various Cecidomyidous galls on the Willow, so Dr. Harris states that "the naked caterpillars of a minute moth are very common in the Warts of the Plum tree," (*Ibid.*) and I have myself found there their pupal exuviæ. 2*nd*. The general appearance of the Black-knot is very similar to that of the Cecidomyidous gall, *S. batatas* n. sp., and like that gall it is said to be "spongy" inside, when young and immature. On examining, Dec. 4th, 30—40 dead and dry specimens, I find that, besides some larger holes through which the Curculio and other inquilines have probably made their escape, they are perforated externally by several round holes, proportionally about $\frac{1}{3}$ as numerous as in the above Willow-gall when it is a year old, and only .020—.025 inch in diameter, which is a trifle smaller than they are in that gall. Now this size is altogether too small for the larva of the Curculio—though it certainly suits well enough for that very rare parasite of the Curculio, *Sigalphus curculionis*, which

has been described by Dr. Fitch; and it is likewise altogether too small for the Lepidopterous pupa, whose exuviæ I detected in this situation I incline to believe that these are the holes through which some Gall-gnat a trifle smaller than *C. s. batatas* has made its exit. At all events, there is no insect known to inhabit the Black-knot, except the very rare *S. curculionis*, to which they can possibly be referred. On cutting into these specimens, their internal structure is found to be the same as that of *S. batatas*, viz. fibres radiating from the axis of the twig, but the intervening matter is more woody than spongy. There have been so many inquilines boring them in all directions, as may be seen from the quantities of "frass" they have left behind them, that it is difficult to ascertain the structure of the cells. In a few specimens, however, which were mostly in their natural condition, I recognized cells, which appeared to me, on comparing the two together, to resemble very strongly those of *Cec. s. batatas*, and to be arranged almost exactly in the same manner; and in these cells there was no "frass" as there always is in the irregular holes inhabited by Curculionidous, Tenthredinidous or Lepidopterous larvæ. *3rd.* Dr. Fitch gives as a reason why the Black-knot cannot be a gall, that "always in galls one or more hard, seed-like bodies are found in the centre, in which the young of the fly producing them is inclosed." (*Rep. Curc. and Bl. Kt.* p. 22.) This is not true of any Cecidomyidous gall known to me, though it applies very well to Cynipidous galls. Hence this argument only proves that the Black-knot is not made by a Gall-fly, but is of no force whatever against the hypothesis of its being made by a Gall-gnat. *4th.* Specimens are said by Dr. Fitch to occur sometimes "wholly free from the Curculio larvæ and all other worms." (*Ibid* p. 22.) Just so in the Cecidomyidous Willow-galls *S. verruca*, *S. semen* and *S. ænigma*, very many galls, be the cause what it may, are solid and tenantless; and out of nine specimens of the Cecidomyidous gall *S. nodulus*, I found two untenanted by any larva and unbored. (See above p. 600.) *5th.* I know by experience how difficult it is to rear *Cecidomyia* to the imago from galls severed from the parent tree, unless fresh specimens are gathered every few weeks to replace the old ones in the breeding-jar. (See above p. 574.) It does not appear that Dr. Fitch took this precaution, and hence, assuming the Black-knot to be the work of a Gall-gnat, I am not at all surprised at his failing to

rear Gall-gnats from it. *6th.* I have not seen a line anywhere in Dr. Fitch's writings, from which it could be inferred, that he was aware of the peculiar character which distinguishes the larva of the Gall-gnats from all other larvæ, viz. the breast-bone. He has described in his Reports the larvæ of three different Gall-gnats, *Cec. grossulariæ* Fitch, *C. pseudacaciæ* Fitch and *C. robiniæ* Hald., yet in no one of these three cases does he breathe a syllable on this very important topic; and, as we have already seen, in the description of the larva of his *Cec. salicis* he mistakes the breast-bone for a part of the head. (See above p. 597.) Hence, even if he had found minute Cecidomyidous larvæ in the Black-knot, he might very possibly have mistaken them for the similarly apod larvæ of the Curculio, which he says that he found in "ALMOST ALL OF THEM." Just so the botanist Schweinitz, who asserts that the larvæ of a minute *Cynips* are found in the Black-knot, (quoted Harris *Inj. Ins.* p. 80,) seems to have mistaken Cecidomyidous larvæ for Cynipidous larvæ; and as we have already seen, (p. 551.) European authors formerly made the same confusion in the case of the insect of the "Rose-willow." *7th.* Gall-gnats, as shown above (p. 552), occur on an immense number of different and widely distinct genera of plants, and the other gall-making genera of insects on comparatively very few genera of plants. Consequently, if the Black-knot is a true gall, and not a mere disease, we may infer *a priori* that it is far more likely to be the work of a Gall-gnat than of any other of the gall insects. *8th.* Just as, with all the Willow-galls originated by Gall-gnats or Saw-flies upon twigs or limbs, and also with similar Oak-galls originated by Gall-flies, and with a hitherto undescribed, oval, Lepidopterous Gall on the twigs of the shrub called Amorpha fruticosa, which I have long noticed and which is produced by *Walshia amorphella* Clemens, and finally with the terminal gall of *Byrsocrypta vagabunda* Walsh, on the tips of the twigs of several poplars, (see *Proc. Ent. Soc. Phil.* II. p. 462,) the twig—unless it is pretty large or unless as in *S. nodulus* n. sp. the insect is very small and only one of them—is always killed by the presence of the gall; so with the Black-knot, as I have myself observed, the smaller limbs are killed by it and the larger ones —say of $\frac{1}{2}$ or $\frac{3}{4}$ inch in diameter—are not so killed. On the other hand the pseudo-gall of the Coleopterous *Saperda inornata* Say, which grows on one of these same Willows, though the actual damage it does to the

wood and bark, so far as we can estimate it by the eye, is proportionably ten times as great as with any gall produced by a Gall-gnat or Gall-fly or Saw-fly or Gall-moth or Plant-louse, yet never, so far as I have noticed, kills the limb on which it grows. The reason is obvious. In a true gall, made for example by a Gall-fly, besides the lesion of the woody fibre and bark, there is, as I have shown, (P. E. S. P. II. pp. 472—6,) poison infused into the wound, the result of which is generally death, unless the poisoned limb is very large and vigorous. In a pseudo-gall there is no such poison infused, and the damage done is simply what would be done, if we were to take an auger and bore the same quantity of wood and bark out of the limb. Whence we may draw this Corollary, that the Black-knot is probably a true Gall; and as from its structure it is manifestly not the work of a Gall-fly or of a Plant-louse, or of a Gall-moth—for the Galls of Gall-flies always contain hard, seed-like kernels and the Galls of Plant-lice and of Gall-moths, so far as my experience extends, are hollow—it follows that it must be the work of a Dipterous fly or else of a Saw-fly. But if it was the work of a Saw-fly, surely Dr. Fitch must have noticed its larva, so closely as he examined the gall; for the larvæ of Saw-flies are pretty large and may be recognized at a glance. Therefore it follows by the method of exhaustion that it must be the work of a Dipterous fly; and as there are but two Gall-making Dipterous families, *Trypetidæ* and *Cecidomyidæ*, and the former is poor and the latter exceedingly rich in species, it is most likely the work of some Cecidomyidous insect. *9th.* As already stated (p. 578, note), I have found on the wild plum, galls strongly resembling the Cecidomyidous gall *S. brassicoides*, and which I have no doubt whatever are, like that gall, Cecidomyidous; and, unless my memory deceives me, I have noticed on the leaves of the wild plum in considerable quantities tubiliform galls strongly resembling the Cecidomyidous hickory-gall *Tubicola* O. S. Now I believe that it is a general law with gall-insects, that where one species of a particular genus exists on a given genus of plants, many other species of the same genus or of closely allied genera coexist with it. (See *Proc. Ent. Soc. Phil.* II. 461–2.) But, with the two exceptions just referred to, there is no Gall-fly or Saw-fly or Plant-louse or other gall-making insect known at present, so far as I am aware, to form galls on the Plum-tree. Hence if the Black-knot is the work of insects—which in spite

of Dr. Fitch's positive asseveration I cannot help believing, and which Peck and Harris and others have believed before me.—it must in all probability, if we assume the truth of the above law, be the work of a Gall-gnat.

That the Black-knot is not, as has been supposed by many, the work of the Curculio, has been sufficiently demonstrated by Dr. Fitch from the fact, that specimens occur without any larvæ at all in them. It might be thought at first sight, that the same fact would bear equally hard against the hypothesis of its being the work of a Gall-gnat. But the singular phenomena with regard to several undoubtedly Cecidomyidous galls, which I have already referred to—no matter to what cause we choose to attribute them—take the case of the Gall-gnats out of the general rule. I will endeavor in this coming spring to examine the recent Black-knots and see whether, as I suspect, they are really inhabited by the larvæ of Gall-gnats, and if so to rear the perfect Gall-gnat from them.

If, then, as I have little doubt, the Black-knot be really a mere Cecidomyidous gall, we can at once solve a problem which has perplexed Economic Entomologists for the last half century, viz: how to get rid of it. All that is required in order to save our diseased Plum-trees from a premature death, is simply to cut off and burn the galls *before* the *Cecidomyia* makes its appearance in the imago state. Cutting off and burning the galls *after* the *Cecidomyia* has made its appearance in the imago state, will be just labor lost; for the eggs are then already laid, that will produce the next year's crop of Black-knot.

It will be noticed, that contrary to the hitherto generally accepted belief, I have not, in the reasonings just now adduced, enumerated Snout-beetles (*Curculionidæ*) as amongst the true Gall-making insects. I doubt very much whether any true Galls are produced by *Curculionidæ*. The holes that these last insects bore are bored, not by any ovipositor, but by their snouts; and to suppose that they can originate true galls, presupposes that they have the faculty of voiding from their snouts poisonous matter, similar to the poisonous matter that I have shown to be deposited along with the egg by the ovipositor of *Cynips*, (*Proc. Ent. Soc. Phil.* II. pp. 472—6), which is contrary to analogy. In all probability the various *Curculionidæ*, that are stated by authors to produce galls, are in reality nothing but inqui-

lines in those galls, just as *Anthonomus scutellatus* Schönh. is inquilinous in the Tenthredinidous gall *S. pomum*, and in several other Tenthredinidous willow-galls, and as the snout-beetles enumerated in this Paper under *Coleoptera* are inquilinous in their respective galls.

INQUILINOUS CECIDOMYIDÆ OR GUEST GALL-GNATS.

Genus **CECIDOMYIA**—Subgenus **CECIDOMYIA.**

A. The following occurs in prodigious abundance under the scales of the pine-cone like Gall, *S. strobiloides* O. S., but not imbedded in any cell, and is probably the species found in the larva state by Baron Osten Sacken in that situation, but not named or described by him, except as being "reddish." I have also bred a few imagos of it from the galls *S. brassicoides* and *S. rhodoides*, and as I found, May 12th, four of its pupal integuments in a vase containing the small variety of the Gall *S. batatas*—which integuments are readily distinguished from those of *C. s. batatas*, not only by their much smaller size, but also by the thoracic bristle and antennal horn being only ½ as long, and immaculate instead of black or tipped with black—I must also have bred them from that gall, though the imagos escaped me. As noticed below, the species is double-brooded, the spring brood coming out from last year's galls, and the autumnal brood from the galls of the same season, so as to be in time to oviposit in the same galls for the brood of the following spring. The two broods were obtained from two distinct lots of galls, each gathered only a few weeks before the insect appeared; so that it must not be supposed that they bred artificially in confinement. Those bred from the galls *S. brassicoides* and *S. rhodoides* belonged exclusively to the autumnal brood. Other double-brooded *Cecidomyia* are stated to exist by Osten Sacken (*Dipt. N. A.* p. 186.) There can be no possible mistake about the identity of the larva, pupa and imago, because on May 3 I bred ♂ ♀ imago from cocoons which I had previously extracted from between the scales of the gall *S. strobiloides* and isolated in a vial, and the other Guest Gall-gnats obtained from this gall occurred exclusively in the autumn. The very general coexistence of these pupal cocoons with the eggs of an *Orchelimum* (see *Proc. Ent. Soc. Phil.* III. p. 232) under the scales of the gall *S. strobiloides*, both of them in very large numbers, was at first very puzzling; and I originally guessed that the Orthopterous eggs were the pupæ of some inqui-

linous Gall-gnat analogous to those of the Hessian Fly, and that what were the real cocoons of inquilinous Gall-gnats were the cocoons of minute Ichneumons that had been preying on the larvæ of the supposed Guest Gall-gnats!

The existence of this species, in the peculiar situation where it is found, solves an interesting question mooted by Winnertz, viz: whether inquilinous Gall-gnats "take the same food with their hosts or live on their excrements." (*Dipt. N. A.* p. 184.) In this case the host lives on the sap of the globular stem, from which all the leaves of the pine-cone like gall proceed, and the guest or inquiline must live on the sap, which he manages to extract from the scales or leaves of the pine-cone. Frequently there is a thickness of .30—.40 inch of solid leaves between the host and the guest, so that it is quite impossible here that the latter can live on the excrements of the former, or interfere with him in any way, except perhaps by slightly diminishing his supply of sap.

Larva.—Dec. 3rd the larva is orange-colored, a little mottled with sanguineous, and sometimes with a broad, dorsal, dark-sanguineous or fuscous vitta abbreviated before and behind. The two tubercles of the anal joint are a little larger and more prominent than usual. The breast-bone is clove-shaped, fuscous, not very distinct, and the stem of the clove is about ¼ as wide as the entire breast-bone is long. Length .03—.04 inch, and breadth rather less than ½ that. Six specimens from cocoons under the scales of the gall *S. strobiloides*. Specimens taken out of the cocoon and examined Feb. 20, at which time none had yet gone to pupa, were orange-color, and on April 29 the breast-bone was darker and very distinct. The *cocoon* is oval, white, much stouter and denser than in any of the preceding species, so that the included larva can only be seen by holding it up to the light, and has a good deal of the white pubescence of the leaves of the gall adhering to it. Length of cocoon .07—.11 inch, breadth .03—.04 inch: 41 specimens which were all obtained from two galls Dec. 3, by which time, and probably long before that, all the larvæ had made their cocoons. Three of these cocoons each contained a yellowish larva, uninclosed in a separate cocoon, and apparently that of a Proctotrupide, one of which was found in the imago state April 29 with its head protruding from one of these cocoons, and another on the same day at large under the scales of the gall.

Pupa.—The first pupa was noticed April 21, but the larva was noticed as late as April 29, and from the first appearance of the imago, some of the insects must have existed in the pupa state at least as early as the first week in April. The abdomen was sanguineous; the rest of the body, including antennæ, legs and wing-cases, fuscous. The horns at the base of the antennæ were rectangularly conical, terminating in a very minute, acute thorn, and divergent in an angle of about 130°. The thoracic bristle was slender and ½ as long as the diameter of the thorax; (in the dried specimen it is terminally fuscous and basally

pale:) and there was no perceptible bristle behind the antennæ. Another, examined May 3, which had worked its way entirely out of its cocoon in the vial where it was isolated, differed in no respect, except that the notum of the thorax was dull sanguineous with two brown vittæ and the scutel sanguineous, and the dorsum of the abdomen was tinged with brown. Length (2 dried specimens) .07 inch. The pupal integument (7 specimens) is white, with the antennæ and the anterior extremity of the body scarcely or not at all tinged with dusky.

Imago. Cecidomyia albovittata n. sp. ♂ ♀ (Recent.)—Generally pale umber-brown, sometimes umber-brown or brown-black, beneath paler. *Head* with its posterior surface uniformly without any white line next the eye. Antennæ ♂ fuscous, fully ¾ as long as the dried body, 14—15-jointed (2+12 to 2+13), tapering towards the tip, the joints of the flagellum spherical, with the pedicels often whitish or translucent and equal in length to the spherical part of the joint, the verticils to the full as long as the two complete joints from which they arise, and the last joint sometimes sessile, sometimes almost confluent with the penultimate, and sometimes represented by a slender, cylindrical prolongation of the penultimate. Antennæ ♀ fuscous, about ½ as long as the dried body exclusive of the oviduct, a little tapered towards the tip, the joints sessile, almost cylindrical at base, perfectly so at tip, so as to be very difficult to count, but probably nearly as numerous as in ♂, the verticils almost reduced to an irregular pilosity scarcely ½ as long as ♂ verticils. *Thorax* with a row of whitish hairs in each longitudinal stria, giving the appearance of two whitish vittæ, and with irregular, lateral, whitish hairs, the 3 interstices glabrous. Origin of the wings and a large spot beneath them orange-color or sanguineous, in the dried specimen dull rufous. Halteres pale, the club more or less infuscated. *Abdomen* ♂ generally clay- or honey-yellow, sometimes yellowish-fulvous, very rarely rufo-sanguineous, the dorsum with short, umber-brown hairs, which occasionally, when the abdomen is much plumped out, become so sparse as to not at all hide the color of the integument, but are almost always located in such a manner and so densely, as to entirely conceal the color of the whole of each joint, or sometimes to conceal only the medial ½ of each joint, and sometimes to conceal all but the sutures. In three specimens where the abdomen, although recent, is much less plump than is usual, and has collapsed so as to leave a deep, dorsal longitudinal stria, the brown hairs are collected in that stria so as to assume the appearance of a narrow, linear, dorsal vitta. Venter with more or less dense, whitish hairs. *Abdomen* ♀ generally bright sanguineous, sometimes sanguineous, rarely rufo-sanguineous, the dorsum with umber-brown hairs varying in their arrangement and denseness precisely as in ♂, except that in two ♀ ♀ the six basal joints, and in two others the three basal joints of the abdomen had their posterior ½ covered by the brown hairs and the anterior ½ glabrous and sanguineous. A ♀, ten minutes after emerging from the pupa, had the dorsum of each joint, except the sutures, concealed by the brown hairs. A single mature ♀ had the anterior ⅔ of the abdomen creamy yellow, with the brown hairs of the dorsum collected in an acute, longitudinal, dorsal stria, so as to simulate a linear, dorsal, brown vitta, as in the 3 ♂ ♂ above referred to, while the posterior ⅓, including the oviduct, was sanguineous and normal with-

out any stria or vitta. Another ♀ showed the same stria rather less deep and acute, but without the normal sanguineous color being changed. Venter with short, white or silvery white, more or less dense, appressed hairs. Oviduct ½—1¼ as long as the rest of the abdomen, almost always yellowish, but in 2 ♀ ♀, besides the one already referred to, it was sanguineous, joints 1—7 of the abdomen being covered by brown hair except the sutures which were sanguineous, and only the 8th or last being glabrous and entirely sanguineous. *Legs* (dried) pale, with their tarsal tips and the whole of their superior surface, except more or less of the basal part of the femur, usually coal-black, but varying all the way to the entire leg being pale and almost immaculate. *Wings* tinged with dusky, from fine appressed, dusky pubescence. The costal vein very stout and black, except in a few specimens where it is less so. The 1st longitudinal vein generally indistinct and more or less confluent with the costal, occasionally pretty distinct and plain. The cross-vein between the 1st and 2nd longitudinal vein obsolete. The 2nd longitudinal vein perfectly straight at tip, and reaching the margin of the wing much before the tip, at a point ⅓ of the way from the point where it attains it in *Cecidomyia* (*Dipt. N. A.* fig. 1. p. 174) to the point where it attains it in *Spaniocera* (*ibid* fig. 6. p. 175), whereas in all the preceding species it reaches it as in *Cecidomyia* (*ibid* fig. 1. p. 174.) Anterior branch of the 3rd longitudinal vein very distinct at its origin, and curved nearly as in *C. s. batatas*, but still more apparently a prolongation of the main vein, and with the tip, as in that species, scarcely recurved. Length ♂ ♀ (dried) .04—.07 inch. Length wing ♂ ♀ .06—.09 inch.

Described entirely from 19 ♂, 24 ♀ of the first or spring brood; but 9 ♂ and 6 ♀ of the second or autumnal brood offered no remarkable variation. The first brood came out April 10—May 14, and in prodigious numbers for several subsequent weeks; the second brood came out July 31—September 11. This species, like *C. s. batatas*, preserves its colors very tolerably in the dried specimen, even as regards the abdomen. From the description of the ♀ abdomen given above, it is manifest that its sanguineous color is due to the included eggs, even the oviduct, which is almost always yellowish, being occasionally sanguineous. The two white vittæ on the thorax, from which the species takes its name, occur also in the Gall-gnat *C. s. batatas* and in the Guest Gall-gnat *C. orbitalis*. Very much like a minute specimen of *C. s. batatas*, but may be distinguished by its smaller size, by the ♂ antennæ having at least 3 joints fewer, by their pedicels being twice as long, and by the 2nd longitudinal vein reaching the margin of the wing further from the tip. The best distinctive character, however, is found in the pupa, which, as it ordinarily has no dense, spongy substance to work its way out through, has short antennal horns, not thickened at tip as

we know that they must be in *C. s. batatas* (pupa), from their tips in the pupal integument of that species being quite black, instead of whitish hyaline as they are in *C. albovittata* (pupa).

B. Of the following species 1 ♂ 3 ♀ were bred from the Cecidomyidous Gall *S. batatas* and 2 ♂ from the Tenthredinidous Gall *S. ovulum*. As there is one variety of *S. batatas* that is undistinguishable externally from *S. ovulum*, which grows on the same willow, it is proper to add here that 1 ♂ 1 ♀ were bred from a variety of *S. batatas*, very distinct from *S. ovulum*, which had been placed in a separate vase from the other varieties, and that of the two ♂ ♂ bred from *S. ovulum*, I recognized the gall from which one ♂ had made its exit by its being the only bored gall in the vase, and on cutting into it found it to be a true *S ovulum* and not a *S. batatas*. I have also a ♀ bred from *S. strobiloides* which can only be referred to this species, though I did not take a description of it while recent, and a ♂ bred from *S. brassicoides* in 1862, of which the same may be said. Thus we find the same species inquilinous in certainly 2, and most probably 4 distinct galls, 3 of them made by Gall-gnats and 1 by a Saw-fly.

Larva unknown.

Pupa (from the pupal integument.)—The antennal horns are obsolete, and the thoracic bristle is about ¼ as long as the thorax is wide. The color of the integument is white, the anterior parts scarcely or not at all tinged with dusky.—Two specimens.

Imago. C. orbitalis n. sp. ♂ ♀ (Recent.)—Dull umber-brown, paler beneath. *Head* with conspicuous white hair above the mouth, and with its posterior surface blackish except a conspicuous, linear, white orbit behind each eye, not interrupted between the eyes, which is apparently produced by very minute white hairs. (In the dried specimen this becomes indistinct, but rarely obsolete.) Antennæ ♂ ⅔—¾ as long as the dried body, 18—19-jointed (2+16 to 2+17), scarcely tapered towards the tip, the flagellar joints globular, the pedicels ½ as long as the joints and whitish or hyaline, the verticils full as long as the two complete joints from which they arise, the last joint in the ♂ with 18-jointed antennæ sessile and apparently almost connate with the penultimate, in the other ♂ pedicelled as usual. Antennæ ♀ nearly half as long as the dried body exclusive of the oviduct, slightly tapered, the joints sessile, almost cylindrical, especially towards the tip, and difficult to count, the verticils reduced to an irregular pilosity half as long as the ♂ verticils. *Thorax* with a row of white hairs in each longitudinal suture, simulating a double white vitta. Origin of wings and a large spot beneath them fulvous or sanguineous. Scutel blackish, a little polished. Halteres whitish, the knob sometimes dusky, and in the specimen from *S. brassicoides* (dried) deep black. *Abdomen* ♂ dull luteous or dull

rufous, dorsally covered with brown hairs, laterally and ventrally with short white hairs, the ventral hairs appressed: sometimes the brown hairs cover the entire dorsal surface, sometimes there are only 2 or 3 of the basal joints dorsally covered with brown hairs on their medial ½, sometimes the basal joint is entirely covered with brown hairs and the 2 or 3 next only medially covered, each succeeding joint for a shorter space, so as to show a wider luteous or rufous band on each succeeding joint. *Abdomen* ♀ with the dorsum sanguineous, rarely dark umber brown: sometimes with the entire dorsal surface covered by short, brown hairs, except the hind edge of each joint, which is covered with cinereous hairs, and the sutures, which are glabrous and dark umber brown: sometimes covered dorsally with brown hairs, except the sutures, which are glabrous, so as to exhibit each a narrow sanguineous band; sometimes with joints 1—7 only slightly covered between the sutural sanguineous bands by brown hairs, and the 8th or last joint, i. e. the last joint of the oviduct, glabrous and fulvous. Venter always sanguineous with short, appressed, whitish pubescence, longer, whiter and denser towards the dorsum. Oviduct ½—¾ as long as the other part of the abdomen, with the last joint very long and always fulvous or yellowish. *Legs* (dried) pale, superiorly black or pale fuscous, except the basal ½ of the femora and sometimes of the tibiæ, and with the terminal ½ or ¾ of the tarsi entirely black; rarely almost immaculate except the tarsi. *Wings* tinged with dusky, from minute, appressed dusky pubescence; the cross-vein between the 1st and 2nd longitudinal veins obsolete; the 2nd longitudinal vein attaining the margin only a little before the tip of the wing (as in *Dipt. N. A.* fig. 1. p. 174), and not recurved at tip. The anterior branch of the 3rd longitudinal vein very distinct at its origin and arising from the main vein nearly as in *C. s. batatas*, with its tip slightly recurved, so that the whole branch nearly follows the curve described by one edge of a lanceolate leaf 5 times as long as wide. Length ♂ .09—.10 inch, ♀ (including oviduct) .10—.15 inch. Length wing ♂ ♀ .13—.14 inch.

Described from 3 ♂ 3 ♀ all recent, besides 1 ♂ and 1 ♀ both dried as before stated. Much smaller than *C. s. brassicoides* and its allies, and distinguishable from them all by the anterior branch of the 3rd longitudinal vein being remarkably distinct at its origin and much straighter and less recurved at tip, and from *C. s. batatas* and all other *Cecidomyia* known to me, when recent, by the remarkable white orbits of its eyes. In all the dried specimens but one, these white orbits are tolerably distinct but not obvious, and they are so also in the specimens from *S. brassicoides* and *S. strobiloides*. The antennal horns of the pupal integument being obsolete, and not distinct, long, and tipped with black, also separates this species effectually from *C. s. batatas*.

C. THE FOLLOWING bores cylindrical holes, like a *Tomicus*, in the solid wood of the largest of the willow-stems from which grow the bunches of the gall *S. brassicoides*, generally pretty close to the points

from which the separate galls of the bunch spring, and generally where a good-sized willow-stem has been arrested in its growth by the galls and forms an elongate-oval swelling, from which arise the galls, and intermixed with them a few slender, half-starved twigs. The interior surface of these holes or burrows is always much blackened and discolored, and they open outwards through the bark, which gave me the first hint of the presence of an insect in so unlikely a locality. But even in so retired a situation as this, ensconced as he is in his burrow and surrounded on all sides by the dense, cabbage-like galls of his Hosts, the avenging Nemesis pursues the unfortunate Guest; for he is preyed upon to a very great extent by a parasitic Chalcidide belonging to *Eurytomides*, which I bred to the imago state from pupæ found in the burrows of the Guest Gall-gnat himself. Thus, even in Insect Life, sooner or later punishment overtakes those, who live, not on the fruits of their own exertions, but by the unrequited toil of their neighbors.

Larva unknown.

Pupa.—Several specimens examined July 15 had the abdomen yellowish or reddish, and the rest of the body, including the antennæ, legs and wing-cases, blackish. The antennal horns were very long, being 1-6th—1-7th as long as the body and projecting almost horizontally forwards so as to touch one another throughout, the basal ½ of each forming a cone with its sides in an angle of about 40°, the terminal ½ suddenly contracted into a slender, cylindrical thorn, scarcely tapered and scarcely acute at tip. Length (living) .09—.12 inch. The pupal integument (1 specimen) has the thorn at the tip of the antennal horn black, showing that that part in the living pupa is thickened for the purpose of enabling it to work its way out through the wood in which it resides. The conical part of the antennal horn, and in a less degree the anterior end of the body, are slightly obfuscated, the rest of the integument, including the antennæ, legs and wing-cases, being as usual whitish-subhyaline.

The antennal horns are much longer in this pupa than in any other known to me, whence the specific name.

Imago. C. cornuta n. sp. ♂ (dried.)—Dull rufous when immature, brown-black when mature, paler beneath. *Head* with the antennæ pale brown, 3-5ths as long as the body, 16—17-jointed (2+14 to 2+15), the same individual in one instance having 16 joints to one antenna and 17 to the other, the flagellar joints globular, the pedicels ½ as long as the joints, the verticils as long as 2½ of the complete joints from which they spring, the last joint whether in the 16- or 17-jointed antenna sessile and closely united with the penultimate. *Thorax* with erect blackish hairs. Scutel and metathorax always dull rufous. Origin of wings and a large spot beneath them dull rufous. Halteres pale, the club blackish even in the immature specimen. *Abdomen* blackish, with rather long, erect

blackish hairs on its dorsum. Venter with dark gray pubescence, and in the immature specimen tinged with rufous. *Legs* pale, very slightly tinged with fuscous above and on the tarsal tips. *Wings* with rather fine, sparse, gray pubescence, but with the normal fringe behind; fringe as long as usual. Costal vein full as slender as the 2nd longitudinal; 1st longitudinal very distinct; cross-vein between 1st and 2nd longitudinal entirely absent; 2nd longitudinal not sinuate or incurved near its base and reaching the margin a trifle nearer the tip of the wing than in Fig. 1. *Dipt. N. A.* p. 174, scarcely recurved at tip, and elsewhere almost perfectly straight, or if anything curved forwards rather than recurved. Anterior branch of the 3rd longitudinal vein slender and in one wing obsolete on its basal ½, in the other wing of the same ♂ it unites normally with the main vein, and nearly describes the curve formed by one edge of a lanceolate leaf 6 times as long as wide. Length ♂ .08 inch; wing ♂ .09 inch.

Described from two ♂, which came out July 15 and shortly afterwards, one of them immature and with the wings badly shrivelled, the other mature; ♀ unknown. Very rare near Rock Island, Illinois. There can be no doubt of the identity of the pupa and imago, as both ♂ ♂ were bred from pupæ dug out of the cylindrical burrows in which they reside.

Genus **CECIDOMYIA**.—Subgenus **DIPLOSIS**.

Like the subgenus *Cecidomyia*, this subgenus seems to consist partly of gall-makers and partly of inquilines. To the true gall-makers belong apparently *D. caryæ* O. S., *D. robiniæ* Hald. and possibly *Cec.* (diplosis?) *pseudacaciæ* Fitch. I describe below four species which are, beyond all doubt, inquilinous in their habits, and it will shortly be shown that the European *D. tibialis* Wz. must be so likewise.

D. **Diplosis atrocularis** n. sp. ♂ ♀ (Recent.)—Whitish, tinged more or less with gamboge-yellow: beneath almost white. *Head* with the eyes coal-black and very conspicuous both in the recent and the dried specimen, whence the specific name. *Antennæ* ♂ very slender, half as long again as the dried body, 23—24-jointed (2+21 to 2+22), the joints globular and slightly obfuscated, in the mature specimen towards the tip of the antenna scarcely or but very slightly large and small alternately, in the less mature specimens more obviously so, difficult to count from 2 or 3 of the terminal ones being sometimes more or less sessile and simulating an elongated club; the pedicels hyaline and as long as the globular part of the joint; the verticils scarcely as long as two of the complete joints from which they spring, usually, except in immature ♂ ♂, directed forwards at an angle of 45° with the axis of the antenna, instead of being nearly at right angles with it. Antennæ ♀ slightly tinged with dusky, much more robust than in ♂, ¾—⅞ as long as the dried body, 14-jointed (2+12), the last joint slenderly cylindrical, acute at tip, sessile, evidently connate with the penultimate, and in the dried specimens sometimes obsolete, so that the antenna is properly 13-jointed, not 14-jointed; the other joints of the flagellum

cylindrical-oval, ½ longer than wide, and all of them as well as the terminal one slightly obfuscated; pedicels hyaline and about ¾ as long as the joints; verticils springing densely and evenly from every part of the oval joint, directed as usual, and about ¾ as long as the complete joint from which they spring. *Abdomen* ♀ with the oviduct scarcely ever exserted, and when exserted only ⅓ as long as the rest of the abdomen. *Legs* with more or less of the tarsal tips, and sometimes the superior surface of the tibiæ, slightly dusky. *Wings* heavily fringed behind, lightly on the costa, covered with minute, appressed hairs, and slightly tinged as well as their veins with gamboge-yellow throughout, or sometimes towards the tip in certain lights with dusky; costal vein moderately robust; 1st longitudinal often not confluent with the costal till it reaches half way to the tip of the wing; cross-vein distinct, placed 1-5th of the way to the tip of the wing. Anterior branch of the 3rd longitudinal springing from that vein at an angle of 135° for a minute space, then curving suddenly and proceeding straight towards the margin of the wing until close to the tip when it is slightly recurved, the whole branch thus describing one half of the outline of the link of a log-chain 6 or 7 times as long as wide and longitudinally bisected. In other respects the neuration agrees precisely with fig. 2, *Dipt. N. A.* p. 174.—Length (dried) ♂ .06—.07 inch, ♀ .05—.07 inch. Wing ♂ .07—.09 inch, ♀ .07—.10 inch.

Described from 4 ♂ 10 ♀, bred from the gall *S. strobiloides* of the same summer's growth, August 31—September 13. I know nothing positively of its Natural History, the larva and pupa being both of them undiscovered by me; but as there was nothing in the vase, where I bred them, but the galls and a few inches of the twig attached to each gall without any leaves remaining on it, the larva must have lived either in one or the other, most probably under the scales of the gall like *Cec. albovittata* n. sp., of which numerous specimens came out in company with it. Thinking it just possible that the pale color in this insect might be partly due to immaturity, I confined one of them in a glass vessel for 24 hours, exposed to the light, and it did not become one particle darker. A European *Diplosis*, *D. tibialis* Wz., was "reared from the same gall as *Cec. salicina* Schr.," according to Osten Sacken, (*Dipt. N. A.* p. 179.) Hence we may conclude that, as my *Diplosis* was an inquiline in a Willow-gall made by a true *Cecidomyia*, the European *Diplosis* was so likewise, both galls, as I infer from the name *salicina*, growing on the willow. *D. atrocularis* ♀ comes very near to *Cec. grossulariæ* Fitch, but in that species the pedicels of the antennæ are only "⅓ as long as the joints," instead of ¾, the oval joints of the antennæ are "more than twice as long as broad" instead of 1½ times as long, and the wings are "faintly tinged with dusky" instead of with

yellow. The number of antennal joints, too, in *grossulariæ* is said to be only 12, instead of 13 or 14; but that may very probably have arisen from the scapus being counted as only one joint instead of two. (See above, p. 557.) Loew, for what reason he does not state, perhaps because the verticils are not mentioned in the description, thinks that Fitch's species "ought, as it seems, to be referred to the subgenus *Asphondylia*," which has no verticils at all ♂ ♀. (*Dipt. N. A.* pp. 7 and 176.) But Fitch refers his species to *Cecidomyia*, which he would scarcely have done if it had been totally without verticils, unless he had at the same time stated the fact of there being no verticils. I suspect it is a *Diplosis*, and that the ♀ only was known to the describer, who says not a word about the sexes in his description.

The subgenus *Diplosis* is circumscribed as having "26-jointed ♂ antennæ with sometimes one additional rudimental joint;" (*Dipt. N. A.* p. 176;) but from carefully examining the dried specimens, I am pretty well satisfied that in *atrocularis*, as well as in *septem-maculata* n. sp., the antennæ ♂ are only 23—25-jointed. Since in the subgenus *Cecidomyia* the number of antennal joints ♂ is confessedly very inconstant, not only differing in different species, but varying even in the same species, and actually in the right and left antenna of the same individual, it seems but agreeable to what I have called the Law of Equable Variability, that it should be somewhat similarly inconstant in the ♂ of the allied subgenus *Diplosis*. The same observations apply in a less degree to the ♀ antenna, which, as stated in the description, is in *atrocularis* properly speaking 13-jointed, though it is limited subgenerically as being "14-jointed with sometimes one additional rudimental joint." The number of joints being so very much smaller in ♀ than in ♂ *Diplosis*, we cannot expect to find the range of variation so extensive in the ♀ as in the ♂. (See above pp. 556–7.) "The number of the joints of the antennæ," says Loew, "is of higher value among the Gallgnats, for the distinction of species, than for that of genera, since *almost every genus comprises species with different numbers of joints of the antennæ.*" (*Dipt. N. A.* p. 179.) We see the same thing in *Cynipidæ*. (*P. E. S. P.* II. pp. 460–1.)

E. D. ATRICORNIS n. sp. (Dried.) ♂ Differs from ♂ of *atrocularis* only as follows:—1*st*. The antennæ are twice as long, instead of half as long again as the dried body, conspicuously stouter, about 24-jointed.

the last joint sessile and closely united with the penultimate, the globular part of the flagellar joints, and also the verticils, coal-black instead of being merely tinged with dusky, and towards the tip of the antennæ the former are alternately small and large, but in a somewhat irregular manner, the larger ones full ½ longer and wider, the smaller ones scarcely shorter and narrower than in *atrocularis*. That it may not be supposed that the difference in color of the globular joints is caused by the degree of maturity, the most mature insect as usual being the darkest colored, it is proper to say here, that one of my ♂ *atrocularis*, which species has the paler antennæ, is decidedly more mature than my *atricornis* which has much the darker antennæ. *2nd.* The legs have the femora superiorly black, otherwise as in *atrocularis*. *3rd.* As in the following species, there is no cross-vein whatever between the 1st and 2nd longitudinal veins, even when the wing is held up to the light under the strongest lens.—Length ♂ .05 inch. Wing ♂ .07 inch. One ♂, reared from *S. strobiloides* galls in the first week of September, along with the preceding and following; ♀ unknown. It might be supposed to be the ♂ of the following, but for the total absence of the 3 spots on the wings, and other differences pointed out under that species.

F. D. ANNULIPES n. sp. (Dried.) ♀ Differs from the ♀ of *atrocularis* only as follows:—*1st.* The antennæ ♀ are nearly as long as the dried body, 12-jointed (2+10) both in the recent and in the dried specimen, instead of 13-jointed, the flagellar joints globular towards the tip, only slightly oval towards the base, the last joint nearly twice as long as broad and tapered to an acute point; the verticils 1—1¼ times as long as the complete joint from which they spring, instead of being only ¾ as long. *2nd.* The legs do not have the femora black above as in *atricornis*, though as in some *atrocularis* the tibiæ are occasionally a little obfuscated above; but they differ remarkably from both species in the terminal ½ or ⅓ of the 2nd or elongated tarsal joint, and the whole of the 4th and 5th tarsal joints being black, the intervening 3rd joint being whitish and thus displaying a conspicuous white annulus, whence the specific name. *3rd.* There are 3 obscurely bounded, pale-dusky spots on the wing, caused by a greater density of the pubescence which is dusky, viz. one subquadrate spot placed ⅔ of the way to the tip of the wing and extending from the 2nd longitudinal to the

costal, which is accompanied by a thickening of that portion of the costal which bounds it; another spot smaller, more indistinct, and sometimes subobsolete, on the tip of the anterior branch of the 3rd longitudinal; and a third spot of a triangular shape, about the same size as the first but the most conspicuous of the three, which occupies the angle where the costal meets the tip of the 2nd longitudinal, and is accompanied by a decided thickening and blackening of that portion of the two veins which bounds it. *4th.* As in *atricornis* there is no cross-vein between the 1st and 2nd longitudinal.—Length ♀ .05—.06 inch. Wing ♀ .07 inch. Three ♀, bred from the gall *S. strobiloides* in the first week of September, along with the two preceding species and great numbers of *C. albovittata* n. sp.; ♂ unknown.

G. **D. septem-maculata** n. sp. ♂ ♀. (Recent.) Dull rufous when immature, blackish when mature, beneath paler. *Head* with the antennæ ♂ ½ longer than the dried body, 23—24 jointed (2+21 to 2+22), the flagellar joints globular and coal-black, the last joint oval and ½ longer than wide, the pedicels whitish-hyaline and about as long as the globular part of the joint, the verticils black, very dense, rather oblique and fully as long as two of the complete joints from which they spring. Antennæ ♀ about ¾ as long as the dried body, 13-jointed (2+11), in one recent specimen 12-jointed (2+10), the flagellar joints dusky, twice as wide as in ♂, short-oval, ¼—⅓ longer than wide, the pedicels whitish-hyaline and ⅔ as long as the oval part of the joint, the verticils fully equal in length to the one complete joint from which they spring. *Thorax* with a row of brownish-yellow hairs in each longitudinal suture of the notum, some irregular lateral ones and the scutel covered with others. Halteres pale. *Abdomen* ♂ (dried) yellowish-brown. Abdomen ♀ sanguineous (both recent and dried), in two dried ♀ yellowish brown. Oviduct almost always retracted, when exserted only as long as one abdominal joint. *Legs* (dried) pale dull luteous, their tarsal tips and often their whole superior surface, except the base of the femora, tinged more or less with dusky, and the entire length of the hind leg ♂ ♀ bipectinated with very fine, sparse, ciliations as long as the hind fringe of the wings. *Wings* deeply tinged with dusky, from minute, appressed, dusky hairs, fringed all round, the costal fringe about ½ as dense and nearly as long as the other part, with 7 obscurely-bounded, whitish-hyaline spots, which are caused by the greater sparseness of the dusky hairs and are situated as follows:—A transverse row of 3 subquadrangular spots placed about ½ of the way to the tip of the wing, forming a fascia across the entire wing, cut in three only by the 2nd and 3rd longitudinal veins, which are dusky here as elsewhere; another subquadrate one about 3-5ths of the way to the tip of the wing, extending all the way from the 2nd longitudinal to the costa; another occupying almost the entire space between the forks of the 3rd longitudinal; another which is occasionally subobsolete, in the angle formed by the union of the 2nd longitudinal with the costal; and a subterminal one, very variable and irregular in its shape and

size, but always narrowly connected with the margin a little before the tip of the anterior branch of the 3rd longitudinal. Neuration normal, save that the cross-vein between the 1st and 2nd longitudinals is entirely absent. Anterior branch of the 3rd longitudinal slender, but distinct throughout, and nearly describing a circular arc of 45°, with the convexity towards the costa. Length (dried) ♂ .05 inch; ♀ .05—.06 inch. Wing ♂ .06 inch; ♀ .06—.07 inch.

One ♂, five ♀, bred from the gall *S. brassicoïdes* Aug. 24—28. Of their Natural History I know nothing. This species may not improbably be identical with Say's *Cec. ornata*, so far as we can judge from his very brief and imperfect description, though it seems that Osten Sacken and Wiedeman still refer that species to *Cecidomyia*, perhaps from not having identified it with any specimens in their possession. Say's species occurred Sept. 13th in Philadelphia, so that the time of capture agrees very well. In any case his description is utterly insufficient to identify any insect in this very difficult family, and ought therefore to be disregarded. The hairiness of the hind legs in *7-maculata* is remarkable and unusual; but, judging from the name, *Cec. hirtipes* O. S. must also have some of its legs hairy, though nothing is said on the subject in the description. In the following species all 6 femora are hairy.

H. **D. decem-maculata** n. sp. (Recent.) ♂ ♀. Pale luteous with sparse whitish-gray hairs. *Head* with the eyes coal-black. Antennæ (dried) ♂ full 1½ times as long as the dried body, 22—25-jointed (2+20 to 2+23), 22-jointed in one recent ♂, the last joint in one of the 25-jointed antennæ tapered suddenly to an acute point; the scapus more elongate than usual: the flagellar joints fuscous, globular, sometimes towards the tip alternately small and large in an irregular manner and with here and there a sessile i. e. double joint; the pedicels whitish-hyaline and about as long as the joints: the verticils dusky, a little oblique and scarcely as long as the two complete joints from which they spring. Antennæ (dried) ♀ nearly as long as the dried body, 12—13-jointed (2+10 to 2+11), in a recent ♀ counted as 13-jointed; the scapus more elongate than usual; the flagellar joints fuscous, oval, and ½ longer than wide; the pedicels whitish-hyaline and about ¾ as long as the joints; the verticils fuscous and fully as long as the complete joint from which they spring. *Thorax* (recent) with a spot above the origin of each wing, and the tip of the scutel, pale fuscous; in one dried ♀ these spots do not appear. Halteres pale, generally with the club a little obfuscated. *Abdomen* (recent) with a terminal dorsal spot on joints 1—5, and a large, lateral, medial spot, which is scarcely interrupted at the sutures, on joints 1—6, all pale fuscous; in one dried ♀ the lateral spots are obsolete, in the others ♂ ♀ they are all as well as the dorsal spots distinct. Oviduct not exserted. *Legs* (recent and dried) whitish, with a pale-fuscous spot on the exterior surface of the coxæ; femora, except towards their bases, fuscous above and laterally, the fuscous color almost meeting below; tibiæ pale fuscous at

tip and almost always at base, rarely with their whole superior surface pale fuscous; the whole of tarsal joints 1 and 5, and the base of 2, and the tips of 2—4, all pale fuscous. Each femur ♂ ♀ is ciliated beneath with gray ciliations, as long as but much more sparse than the hind fringe of the wings. *Wings* as well as their veins, except the posterior branch of the 3rd longitudinal which is whitish, pale fuscous from minute, appressed hairs, except on the following spots, where they are whitish-hyaline from the hairs becoming sparse, the pale spots dominating the dark ground-color.—Between the 1st and 2nd longitudinals, halfway to the tip of the wing, a large spot, twice as long as wide and extending from one vein to the other, and 2 subsemicircular spots with their diameter resting on the costal and their circumference generally not quite reaching the 2nd longitudinal, the first spot ¾ of the way to the tip of wing and the last close to the tip. Between the 2nd and 3rd longitudinals a triangular basal spot extending to both veins and reaching to the point where the wing suddenly becomes wider; a large rhomboidal spot conterminous with the 1st or large costal spot and only divided from it by the 2nd longitudinal which here as elsewhere is pale fuscous; a small, round, isolated spot ¾ of the way to the tip of the wing; and a large subtriangular spot commencing just beyond the small spot, and extending to each vein laterally and to the terminal margin, except that it abuts on the middle of its terminal boundary on a pale-fuscous, terminal spot. Behind the 3rd longitudinal 2 subquadrangular spots—the first elongate and subbasal, the second abbreviated and straddling the posterior branch of the 3rd longitudinal, and both of them extending from vein to margin with but a narrow fuscous space on the basal and terminal side of each—and a triangular spot occupying the terminal ⅓ of the space between the forks of the 3rd longitudinal; making in all 10 spots, arranged in 3 rows, 3 and 4 and 3 in a row. Ciliations extending all round the wing, as long but only about ½ as dense on the costa as behind. No cross-vein between the 1st and 2nd longitudinals. Anterior branch of the 3rd longitudinal very distinct, and so nearly straight that it describes a circular arc of about 25°. Neuration otherwise normal.—Length (dried) ♂ .05—.06 inch, ♀ .06—.07 inch. Length wing ♂ .07 inch, ♀ .07—.10 inch.

Two ♂, three ♀, bred from the gall *S. strobiloides* Aug. 28—Sept. 1. The ornamentation of the legs agrees almost exactly with that of *D. maccus* Lw., though from some cause or other, perhaps because the legs were all mutilated, Loew omits all mention of the coloration of the 5th tarsal joint of that species; but the structure and coloration of the antennæ and the spottings of the wings are quite different in the two. This is a most elegant species, and the spots of the wings are well defined and bright, not obscure and indefinite as in *7-maculata*.

BIBIONIDÆ.

1. SCATOPSE RECURVA? Lw. I bred a single specimen some years since from the Tenthredinidous gall, *S. pomum* n. sp.

DROSOPHILIDÆ.

J. Drosophila amœna Lw. I bred eight specimens of this elegant little insect Aug. 17—27, from the gall *S. strobiloides*. Baron Osten Sacken, to whom I am under obligations for determining both this and the preceding species, observes as follows in regard to its habits:—"The genus *Drosophila* occurs in the vicinity of acid or fermenting matters, as vinegar, decaying apples, &c., in which the larvæ live. *D. amœna* occurs commonly among decaying leaves, and the occurrence of its larva in the gall *Strobiloides* is probably not the general rule. I have found the fly abundantly in places where hardly any Willows were to be met with."—As I have 6 specimens, all captured at large at the same time near Rock Island, it must be tolerably common there also.

TACHINIDÆ.

A gray species .09 inch long was bred Sept. 1 from the Tenthredinidous gall *S. pomum*. It might have been parasitic either upon the author of the gall, or upon a beautiful harlequin-like, 12-banded, Lepidopterous larva, which is commonly inquilinous there, but which I have not yet succeeded in raising to the imago.

A robust, blackish species, .14 inch long, was bred Aug. 18 from the Cecidomyidous gall *S. brassicoides*. It seems almost too large to have infested any of the 5 species of Lepidoptera that I have found to be inquilinous in that gall; but as I bred therefrom a single specimen of the common *Loxotænia rosaceana* Harr., which must have accidentally got in among the expanded leaves of the galls, it might possibly have been parasitical upon some such larva. I have neither the facilities, nor the time, nor the requisite experience, to determine the above 2 species either generically or specifically, and therefore dismiss them with this brief notice.

And now, after toiling through all these long and frequently tedious details—after we have seen that the Gall-gnats of the Willow, though they are essentially distinct species, yet resemble one another so closely, that in almost all cases it is difficult, and in some cases impossible to distinguish the imagos one from the other—after we have seen that species inhabiting monothalamous bud-galls of the same fundamental structure, such as the first six described above, are in the imago state

either exactly or almost exactly alike, and that a species, *S. batatas*, which inhabits a polythalamous twig-gall of a totally different structure, is comparatively speaking widely distinct from the first—after we have traced the same law even in the larvæ, and found that those which inhabit the bud-galls are yellowish with whitish markings and all exactly alike, and that which inhabits the twig-gall is sanguineous marked with yellowish and has a totally different breast-bone—after we have seen the Guest Gall-gnats, not themselves making any galls, but dwelling in galls constructed by the true Gall-makers, generally in those of such species as are allied to themselves, and but rarely in those of species belonging to different Families and different Orders, and one of them, *Cec. albovittata* n. sp., so closely resembling a true gall-making Gall-gnat, *Cec. s. batatas* n. sp., that at the first glance they can only be distinguished by a trifling difference in size—after we have remarked that even authors, like Osten Sacken, who cannot be supposed to be led away by any visionary theories, have dilated upon the great apparent similarity between several species of true, gall-making Gall-flies and the Guest Gall-flies that intrude upon their homes (*Proc. Ent. Soc. Phil.* II. p. 34)—the mind naturally enquires, what is THE MEANING of these and similar phenomena? Natural History is not, as some have foolishly supposed, a mere bundle of dry facts. These, it is true, form the foundation upon which we must build, and, without such a solid and immoveable base to build on, the whole edifice will crumble to dust with the first blast that assails it. But Science, to be worthy of that high and holy name, must not be contented with mere facts. Her aim is to generalize upon those facts, when a sufficient number of them has been accumulated—to curiously pry into the laws which govern the great system of which we ourselves form but an infinitesimally small fragment—to ascend from minute details to broad and sweeping inductions—in a word, to solve the great mystery of the Creation and explain to us how, and why, and wherefore we exist.

Geology has already told us much on this subject. Zoology, her sister and hand-maiden, has also told us much and can tell us much more. The GEOGRAPHICAL DISTRIBUTION of species demonstrates, that they cannot have all spread in their present specific types from one common centre of creation, and that if we assume several distinct centres of creation within the present geological epoch, we must assume

at least a thousand of them; and even then the occurrence of very many identical species in faunas and floras which, as Geology teaches us, were separated by insurmountable physical barriers long before the present geological epoch commenced, and have continued to be so separated ever since, forms an almost insuperable objection to the hypothesis. The only other assumption that we can make—after rejecting the above two—is that species were not created in their present specific types, but are genetically derived from pre-existing species. The Unity of Coloration, both as regards the shade of color and the pattern or design, which prevails almost everywhere in Nature in the same group of species, likewise indicates by unmistakeable tokens a genetic connection between the different species of those groups. There is actually, as I have attempted to show, a very general Phytophagic Unity in those genera of insects which in the larva state feed upon plants; for it is very commonly the case that certain genera of insects inhabit, more or less exclusively, certain genera of plants; and I believe that when one species of a given genus of gall-making insects is found on a given genus of plants, there can be almost universally many more species of the same genus found there. At all events, the Gall-gnats of the Willow offer a memorable illustration of this rule; for before this Paper appeared but a single N. A. species was known to the scientific world, and I have discovered at least fourteen additional species, and doubtless many more remain to be discovered. To say, by way of explanation of these and similar phenomena, that they are so because the Great Author of Nature has willed them to be so, is no explanation at all, but simply a woman's reason—it is so, because it is so. If I were to go into a large stable of horses, and find some of them fed exclusively on maize, some exclusively on oats, some exclusively on hay, and some, as usual, on an intermixture of the three kinds of feed, I should naturally ask the horse-keepers what was the reason of this singular anomaly. Would it be any answer for them to say—"It is so, because the Master has willed it to be so"? What I should want to know would be, *why* he willed it to be so, and what possible reason he could have for such a proceeding; and unless they could explain this point, they might just as well hold their tongues. Now the Derivative Theory explains fully and completely what I called just now the Phytophagic Unity of numerous large groups of insects, and it also

explains fully and completely that COLORATIONAL UNITY which we find to prevail everywhere in Nature. The Creative Theory has hitherto failed to give any explanation whatever, deserving the name of explanation, of numberless such phenomena as these. What I have called the UNITY OF HABITS (see above p. 570) points like a finger-post in the same direction as the PHYTOPHAGIC UNITY of genera; and there is even, as Prof. Agassiz was perhaps the first to clearly point out, both a UNITY OF VOICE in the same family of animals and also a UNITY OF MOTION. (*Methods of Study*, pp. 121–5.)

It is true that these last three Unities are dependent upon Structure, and as our Systems of Classification are founded upon Structure, we might naturally expect that where the Structure is nearly identical, the Habits, and the Voice, and the Motion should also be nearly identical. But, so far as we can discover, Coloration is entirely independent of Structure, and does not form any part of the basis of our present Classifications, though some Naturalists are beginning to recognize it as of generic value. No man ought to wonder that one *Cicindela*, for example, is structurally like another *Cicindela*, for it is precisely *because* they are structurally alike that both are referred to the same genus; but it is most surprising, that, although Coloration has had nothing to do with their Classification, and there are hundreds of species known and described, there is the same fundamental design or pattern on the elytra of all of them.* On the Creative Theory, who can assign even a probable reason for this and a whole host of similar phenomena? Who can explain why *Gomphus*, of which there are now 86 described species, should always be yellow or greenish-yellow, and, according to Selys and Hagen, have normally 6 black stripes on what is called the dorsum of the thorax? Why *Coccinella* and *Hippodamia* should have red or yellow elytra dotted with black, and *Cicindela* have green or red or brown-black elytra, with all the intermediate grades of color, marked by three white lunules on certain definite parts? Why *Pterostichus* should be black and *Pœcilus* metallic green or blue? Why *Pieris* and *Pontia* should be white spotted with black, and *Hipparchia* and

* See on this subject Dr. LeConte's Memoir on the Cicindelidæ of the U. S. (*Trans. Am. Phil. Ent. Phil. Soc.* XI. p. 28.) Dr. LeConte found that *C. 4-lineata* Fabr., an East Indian species which has instead of the normal markings "two yellow stripes on each elytrum," had certain structural peculiarities which authorized its being placed in a new genus, *Hypœtha* Lec.

its allies brown with eye-like subterminal spots; while *Melitæa* and *Argynnis* are fulvous or fulvous red above, with crenulate lines and lunules of black on certain fixed parts of the wing?

Again, it is difficult to conceive of any peculiarity in structural organization, which can account for the wonderful phenomena of PHYTOPHAGIC UNITY; why, for example, *Cynips* should form galls on the Oak and never on the Rose, and *Rhodites* should form galls on the Rose and never on the Oak; why *Pontia* and *Pieris* should affect cruciferous plants, *Colias* the clovers, *Parnassius* the saxifrages, and *Argynnis* the violets. We find that, even within the boundaries of the United States, the gall-making genus *Cecidomyia* inhabits at least 8 distinct genera of plants. (See above p. 552.) Why are the gall-making genera *Cynips* and *Rhodites* each restricted to a single genus of plants? We find that *Arctia* and its allies are very generally polyphagous, and feed on an almost unlimited number of different genera of plants. Why is *Arctia* polyphagous, and *Pontia* and *Pieris* and *Colias* and *Parnassius* and *Argynnis* generally monophagous? It is inconceivable to me, that in genera all belonging to the same Order, as with these last, there can be fundamental and immutable differences in the structure of their mouths or their stomachs, of such a nature as to enable the one to eat and digest almost anything of a vegetable nature, and to compel the others to restrict themselves, as a general rule, for thousand and thousands of years to one single genus of plants. Look at the exclusively American Lepidopterous family *Dryocampadæ*. Within the limits of the United States there are now known to be eight, or in any case seven species belonging to this family. Six (or five) of them belong to the genus *Dryocampa*, and out of the six (or five) no less than *four*, *pellucida*, *senatoria*, *stigma* and *bicolor*—or, at all events, if *bicolor* be not, as I believe it to be, a true species, no less than *three*—inhabit the Oak in the larva state. Of the remaining two, *rubicunda*, which inhabits the Maple, is rather an aberrant form, and *imperialis*, which inhabits the Sycamore (Platanus), the Pine, the Sweet-gum (Liquidamber) and occasionally the Oak, is a decidedly aberrant form. The other two genera of this family, *Ceratocampa* Harris and *Sphingicampa* Walsh, each containing one N. A. species, are, but more especially the latter, pre-eminently aberrant forms; and it is most remarkable that neither of them has ever been found on the Oak, the former feeding

on the Walnut (Juglans), the Hickory (Carya) and the Persimmon (Diospyros), and the latter, so far as hitherto known, feeding exclusively on the Honey-locust (Gleditschia). Now, from the fact that there are two of these *Dryocampa* which do not inhabit the Oak, it is manifest that there can be no generic peculiarity of structure which compels the entire genus to confine themselves to that tree. Why then, out of five or six *Dryocampa*, do as many as three or four inhabit the Oak? Why are they not scattered round amongst our Elms and Ashes and Cherries and Plums and Thorns and Crabs and Willows and Poplars and Beeches? The Theory of Chances demonstrates that this cannot be a merely fortuitous event. There MUST be some cause for it. What is that cause? The Creative Theory is dumb, or tells us that it is so, because it is so; the Derivative Theory answers promptly, clearly and loudly, that it is because all *Dryocampadæ* sprang ages ago from some one pre-existing species, which inhabited the Oak or some pre-existing form closely allied to the Oak; and that certain nascent types, in the course of ages, ceased more or less, and at a more or less early period, to feed on the Oak, so as to become isolated from their brethren at a comparatively early date, and have consequently deviated more or less, but always in a far greater degree than the others, from the primordial type, and run into what I have called Phytophagic Species. Look, again, at the cases of the N. A. Gall-gnats (*Cecidomyia*) which form galls on the Willow, and of the N. A. Gall-flies (*Cynips*) which form galls on the Oak. I know from my own observation of both these two groups that, as a general though not as a universal rule, each species is limited to a particular species of the genus of Plants which it inhabits. In the case of the latter, Osten Sacken has shown the same thing, (*Proc. Ent. Soc. Phil.* I. p. 50,) and as to the former, both Loew and Osten Sacken assert it of the whole family of *Cecidomyidæ*. (*Amber-Dipt.* Sill. Journ. XXXVII. p. 309. *Dipt. N. A.*, p. 179.) It cannot be said that there is some peculiarity in their generic organization, which limits them thus to one or other particular species either of Oak or Willow; for there are probably certain species of Gall-gnats which inhabit several species of Willow, and there are most indubitably certain species of Gall-flies which inhabit several species of Oak.* Con-

* The N. A. Oaks (quercus), are divided by Gray into two sections which almost attain a subgeneric value, from the circumstance of the acorns either ripening the

sequently, whatever the structural character be which limits them to one Willow or one Oak, it must be specific and not generic. Now is it conceivable, so closely as most of these Gall-gnats and many of these Gall-flies are allied, and so closely as most Willows and most Oaks are allied, that there can be fundamental and immutable specific differences in the organization of almost all these N. A. Gall-gnats and Gall-flies, which have compelled them for all time, ever since their first so-called original creation, to inhabit one particular species of Oak or of Willow, and to perish if they are transferred to any other species? Yet, if we believe in the Creative Theory, we are bound to believe this. We are bound to believe, for example, that two distinct species of the Gall-flies of the Oak—*Cynips q. spongifica* O. S. and *C. q. inanis* O. S.—which, if they differ at all in their organization, differ by such exceedingly minute differences, that, on the closest scrutiny under the most powerful

same year or not till the following year. It is a suggestive, and certainly not a merely fortuitous fact, that those Gall-flies which inhabit promiscuously several species of Oak, confine themselves to one or the other Section or Subgenus: e. g. *Cynips q. globulus* Fitch, occurs on Q. alba and Q. montana, and also, unless I have been deceived by the similarity of the gall, on Q. macrocarpa, all three of them belonging to the first section or subgenus; and *C. q. petiolicola* Bassett occurs on Q. prinus (=Q. montana) and Q. prinoides, all three of them likewise belonging to the first section or subgenus. The rest all occur exclusively on Oaks belonging to the second section or subgenus, viz., *C. q. palustris* O. S. on Q. palustris, Q. tinctoria (=Q. coccinea), Q. imbricaria, Q. falcata and Q. ilicifolia; *C. q. operator* O. S. on Q. nigra, Q. palustris and Q. ilicifolia; and *C. q. Osten Sackenii* Bassett on Q. ilicifolia and Q. coccinea. *C. q. sculpta* Bassett, which Mr. Bassett found on Q. rubra, I have since bred from precisely similar galls on Q. tinctoria: and I found last August and early in September, in very great numbers both on Q. rubra and Q. tinctoria, growing *from the side of the cup of the acorn*, a globular, smooth, plum-like, fleshy, intensely bitter gall, about .50—.75 inch in diameter, mottled with yellowish and crimson outside, and internally yellowish in the centre and towards the circumference pink like a water-melon. This gall, of which I forwarded a specimen to Baron Osten Sacken, is thought by him to be identical with his *Q. juglans*, which was described only from dry, shrivelled-up specimens, and which was stated by Mr. Hitz who found it "to grow on the *branches* of the *White Oak*," (Q alba,) a species that belongs to the first section of Quercus. Either Mr. Hitz must have been mistaken, both as to the tree and the part of the tree on which he found *Q. juglans* O. S., or else my gall is a distinct species. If so, I propose for it the name of *Q. prunus*. It is the only N. A. Cynipidous gall known so far to grow on *the acorn*, though, judging from the names, the European Cynipidous galls, *q. calicis* and *q. bacearum*, grow the one on the cup of the acorn, like *q. prunus*, and the other on the acorn itself.

glasses, neither Baron Osten Sacken nor myself can discover any distinctions whatever between them, have yet retained these infinitesimally minute distinctive characters unchanged and unimpaired for 5,000 or 50,000 or 500,000 years, or whatever other limit we may choose to assign to the present Geological era. I could as soon believe that it is possible, by the most unremitting attention, to propagate the same breed of cattle, without losing or in any wise changing a single point that characterizes the breed, for 1000 years; whereas we know that it is practically impossible to do this even for 30 or 40 years.

If, indeed, we only met with these Colorational and Phytophagic Unities in one geographical district, we might suppose them to be caused by some peculiarities of climate. But go where you will, the same universal laws follow you. The *Cynips* of Europe, like their American congeners, inhabit the Oak and not the Rose, and the *Rhodites* of Europe, like the *Rhodites* of the U. S., are found exclusively on the Rose and never on the Oak. The *Gomphus* from Japan and the *Gomphus* from the Kurile Islands have the same yellowish ground-color, and the same black stripes on the thorax, as the *Gomphus* of North America and the *Gomphus* of Europe. The *Cicindela* from Hindostan, so far as regards the elaborate pattern traced on its elytra, is as like as two peas to the *Cicindela* of the United States and the *Cicindela* of England. And the same law holds good on both sides of the Atlantic, as regards both the coloration and the food-plant of *Pontia*, and *Pieris*, and *Colias*, and *Argynnis*, and *Hipparchia*.

These illustrations might be indefinitely prolonged; but every naturalist can supply the deficiency from facts which have come under his own observation, and I only refer to them here because they have scarcely been touched upon in Darwin's great work. The absolute identity in the imago state of several distinct species of *Cecidomyia*, as shown in this Paper—the absolute identity in the imago state of two distinct species of *Halesidota*, which I have demonstrated in a preceding Paper—the COLORATIONAL UNITY so especially remarkable in Insecta, where we have so large a number of species to generalize upon—the PHYTOPHAGIC UNITY of very many genera of Insects—like myriads of other facts enumerated in the Origin of Species, all cry out with one voice, that species are connected by a genetic bond—that they were not independently created, but derived by gradual modification

during indefinitely long periods of time from pre-existing species—that the Great Author of Nature constructed his primordial Cosmos in so perfect a manner, that ever thereafter it needed no interference on his part—that it is not like the bungling machines put together by human hands, which wear out in a few years and require constant attention and supervision—but that, without any miraculous interposition on the part of the Creator, the Creation has heretofore run, and will continue hereafter to run its appointed course, one geological epoch gradually succeeding to another, and one species gradually arising from and supplanting another, till it shall seem fit to the Great First Cause to destroy that work which, when he called it into being, "he saw to be good," good not only for one brief geological era but for all time.

Rock Island, Illinois, Dec 14. 1864

POSTSCRIPT.

Since my remarks on the "Unity of Habits" in Insects were in print, (pp. 567, 570, 574,) I have been much pleased to find that Professor Agassiz recognizes the same great Law, with apparently the same limitations, as regards animals generally, and extends it not only to the genus, as I have done, but to the family. "The more I learn upon this subject," he says, "the more am I struck with the similarity in the very movements, the General Habits, and even the intonation of the voices of animals, belonging to the same family." (*Essay Classif.* p. 59.)

It may be asked how I, who believe firmly in the Derivative Origin of Species, can believe that it is impossible for species of the same genus to have several heterogeneous and widely different habits. "Your *Unity of Habits*," it may be objected, "is irreconcileable with the theory of the gradual development of existing species from pre-existing species. If one species is derived from another, must not the new species, while in an incipient state, differ in its organization and often in its habits from what may be called the mother-species? May not the *Cecidomyia* that are said by Wagner to procreate in the larva state, be simply a new genus in an incipient or nascent condition, that will hereafter perhaps become developed into a whole family of insects having the same peculiar and extraordinary habits?" I reply, in the words of Linnæus, *Natura non agit per saltum*. If Nature wished to construct a race of insects, that should habitually commence making new